Spreadsheet Munging Strategies

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Contents

Welcome

This is a work-in-progress book about getting data out of spreadsheets, no matter how peculiar. The book is designed primarily for R users who have to extract data from spreadsheets and who are already familiar with the tidyverse. It has a cookbook structure, and can be used as a reference, but readers who begin in the middle might have to work backwards from time to time.

R packages that feature heavily are

- unpivotr: deals with non-tabular data, especially from spreadsheets.
- tidyxl: imports non-tabular data from Excel files

Tidyxl and unpivotr are much more complicated than readxl, and that's the point. Tidyxl and unpivotr give you more power and complexity when you need it.

Please help me to improve this book by opening a GitHub issue or tweeting.

Figure 1: Creative Commons License

Chapter 1

Setup

This section describes how the code in the book is set up.

1.1 Packages

Here are the packages used by the code in this book. The last three are my own: tidyxl, unpivotr and smungs. You will need to install the latest versions from CRAN or GitHub.

```
library(tibble)
library(tidyr)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(purrr)
library(stringr)
library(readr)
library(readxl)
library(tidyxl)
library(unpivotr)
library(smungs) # GitHub only https://github.com/nacnudus/smungs
```

1.2 Data

The examples draw from a spreadsheet of toy data, included in the unpivotr package. It is recommended to download the spreadsheet and have open it in a spreadsheet application while you read the book.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
```

Chapter 2

Tidy-ish tables

This chapter is a gentle introduction, by taking what you already know about importing tidy tabular data (with `read.csv()` or the readr package), and shows you how to how to do the same things with tidyxl and unpivotr. It works up to tables that are mostly tidy, but have subtle problems.

2.1 Clean & tidy tables

	A	B
1	**Name**	**Age**
2	Matilda	1
3	Nicholas	3
4	Olivia	5

If the tables in the spreadsheet are clean and tidy, then you should use a package like readxl. But it's worth knowing how to emulate readxl with tidyxl and unpivotr, because some *almost* clean tables can be handled using these techniques.

Clean and tidy means

- One table per sheet
- A single row of column headers, or no headers
- A single data type in each column
- Only one kind of sentinel value (to be interpreted as `NA`)
- No meaningful formatting
- No data buried in formulas
- No need to refer to named ranges

Here's the full process.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
xlsx_cells(path, sheet = "clean") %>%
```

```
  behead("N", header) %>%
  select(row, data_type, header, character, numeric) %>%
  spatter(header) %>%
  select(-row)
```

```
## # A tibble: 3 x 2
##     Age Name
##   <dbl> <chr>
## 1     1 Matilda
## 2     3 Nicholas
## 3     5 Olivia
```

`tidyxl::xlsx_cells()` imports the spreadsheet into a data frame, where each row of the data frame describes one cell of the spreadsheet. The columns `row` and `col` (and `address`) describe the position of the cell, and the value of the cell is in one of the columns `error`, `logical`, `numeric`, `date`, `character`, depending on the type of data in the cell. The column `data_type` says which column the value is in. Other columns describe formatting and formulas.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
xlsx_cells(path, sheet = "clean") %>%
  select(row, col, data_type, character, numeric)
```

```
## # A tibble: 8 x 5
##     row   col data_type character numeric
##   <int> <int> <chr>     <chr>       <dbl>
## 1     1     1 character Name           NA
## 2     1     2 character Age            NA
## 3     2     1 character Matilda        NA
## 4     2     2 numeric   <NA>            1
## 5     3     1 character Nicholas       NA
## 6     3     2 numeric   <NA>            3
## 7     4     1 character Olivia         NA
## 8     4     2 numeric   <NA>            5
```

`unpivotr::behead()` takes one level of headers from a pivot table and makes it part of the data. Think of it like `tidyr::gather()`, except that it works when there is more than one row of headers (or more than one column of row-headers), and it only works on tables that have first come through `unpivotr::as_cells()` or `tidyxl::xlsx_cells()`.

```
xlsx_cells(path, sheet = "clean") %>%
  select(row, col, data_type, character, numeric) %>%
  behead("N", header)
```

```
## # A tibble: 6 x 6
##     row   col data_type character numeric header
##   <int> <int> <chr>     <chr>       <dbl> <chr>
## 1     2     1 character Matilda        NA Name
## 2     2     2 numeric   <NA>            1 Age
## 3     3     1 character Nicholas       NA Name
## 4     3     2 numeric   <NA>            3 Age
## 5     4     1 character Olivia         NA Name
## 6     4     2 numeric   <NA>            5 Age
```

`unpivotr::spatter()` spreads key-value pairs across multiple columns, like `tidyxl::spread()`, except that it handles mixed data types. It knows which column contains the cell value (i.e. the `character` column or the `numeric` column), by checking the `data_type` column. Just like `tidyr::spread()`, it can be confused by extraneous data, so it's usually a good idea to drop the `col` column first, and to keep the `row` column.

```
xlsx_cells(path, sheet = "clean") %>%
  select(row, col, data_type, character, numeric) %>%
  behead("N", header) %>%
  select(-col) %>%
  spatter(header) %>%
  select(-row)
```

```
## # A tibble: 3 x 2
##     Age Name
##   <dbl> <chr>
## 1     1 Matilda
## 2     3 Nicholas
## 3     5 Olivia
```

In case the table has no column headers, you can spatter the `col` column instead of a nonexistent `header` column.

```
xlsx_cells(path, sheet = "clean") %>%
  dplyr::filter(row >= 2) %>%
  select(row, col, data_type, character, numeric) %>%
  spatter(col) %>%
  select(-row)
```

```
## # A tibble: 3 x 2
##   `1`         `2`
##   <chr>     <dbl>
## 1 Matilda       1
## 2 Nicholas      3
## 3 Olivia        5
```

Tidyxl and unpivotr are much more complicated than readxl, and that's the point: tidyxl and unpivotr give you more power and complexity when you need it.

```
read_excel(path, sheet = "clean")
```

```
## # A tibble: 3 x 2
##   Name        Age
##   <chr>     <dbl>
## 1 Matilda       1
## 2 Nicholas      3
## 3 Olivia        5
```

```
read_excel(path, sheet = "clean", col_names = FALSE, skip = 1)
```

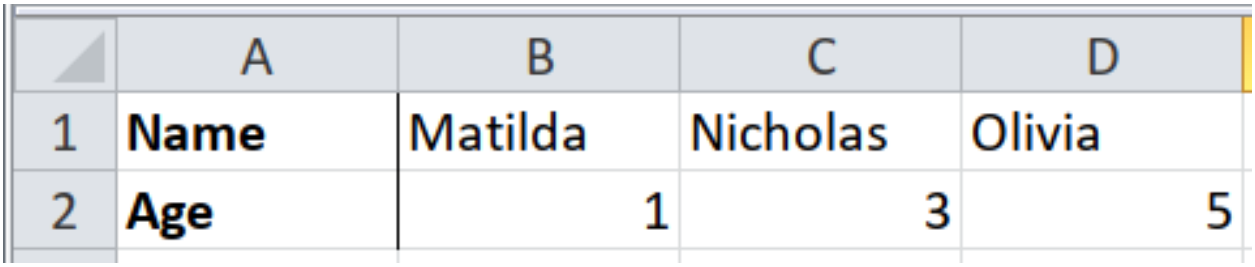
```
## # A tibble: 3 x 2
##   X__1       X__2
##   <chr>     <dbl>
## 1 Matilda       1
## 2 Nicholas      3
## 3 Olivia        5
```

2.2 Almost-tidy tables

For tables that are already 'tidy' (a single row of column headers), use packages like readxl that specialise in importing tidy data.

For everything else, read on.

2.2.1 Transposed (headers in the first row, data extends to the right)



	A	B	C	D
1	**Name**	Matilda	Nicholas	Olivia
2	**Age**	1	3	5

Most packages for importing data assume that the headers are in the first row, and each row of data is an observation. They usually don't support the alternative: headers in the first column, and each column of data is an observation.

You can hack a way around this by importing without recognising any headers, transposing with `t()` (which outputs a matrix), placing the headers as names, and converting back to a data frame, but this almost always results in all the data types being converted.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
read_excel(path, sheet = "transposed", col_names = FALSE) %>%
  t() %>%
  `colnames<-`(.[1, ]) %>%
  .[-1, ] %>%
  as_tibble()
```

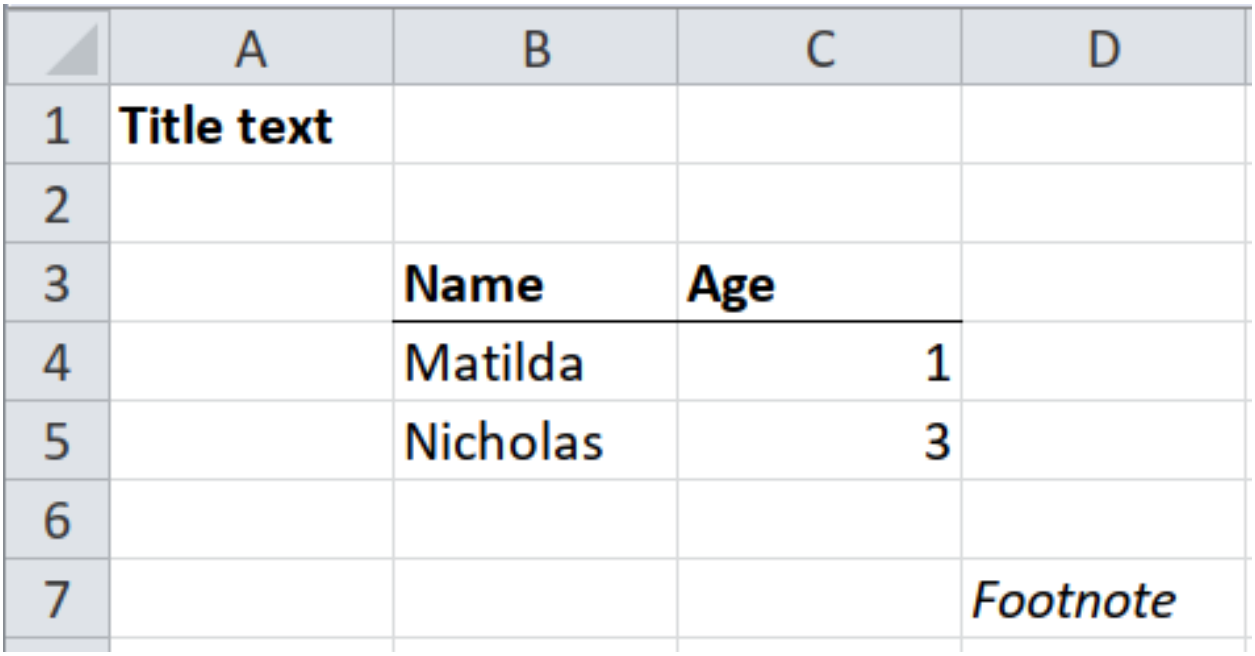
```
## # A tibble: 3 x 2
##   Name     Age
##   <chr>    <chr>
## 1 Matilda  1
## 2 Nicholas 3
## 3 Olivia   5
```

Tidyxl and unpivotr are agnostic to the layout of tables. Importing the transpose is the same is importing the usual layout, merely using the `"W"` (west) direction instead of `"N"` (north) when beheading the headers.

```
xlsx_cells(path, sheet = "transposed") %>%
  behead("W", header) %>%
  select(col, data_type, header, character, numeric) %>%
  spatter(header) %>%
  select(Name, Age)
```

```
## # A tibble: 3 x 2
##   Name       Age
##   <chr>    <dbl>
## 1 Matilda      1
## 2 Nicholas     3
## 3 Olivia       5
```

2.2.2 Other stuff on the same sheet



	A	B	C	D
1	**Title text**			
2				
3		**Name**	**Age**	
4		Matilda	1	
5		Nicholas	3	
6				
7				*Footnote*

It will be more complicated when the table doesn't begin in cell A1, or if there are non-blank cells above, below or either side of the table.

If you know at coding time which rows and columns the table occupies, then you can do the following.

- Blank or non-blank cells above the table: use the `skip` argument of `readxl::read_excel()`.
- Blank or non-blank cells either side of the table: use the `col_types` argument of `readxl::read_excel()` to ignore those columns.
- Blank or non-blank cells below the table: use `n_max` argument of `readxl::read_excel()` to ignore those rows.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
readxl::read_excel(path,
                   sheet = "notes",
                   skip = 2,
                   n_max = 33,
                   col_types = c("guess", "guess", "skip")) %>%
  drop_na()
```

```
## # A tibble: 2 x 2
##   Name       Age
##   <chr>    <dbl>
## 1 Matilda      1
## 2 Nicholas     3
```

If you don't know at coding time which rows and columns the table occupies (e.g. when the latest version of the spreadsheet is published and the table has moved), then one strategy is to read the spreadsheet with `tidyxl::xlsx_cells()` first, and inspect the results to determine the boundaries of the table. Then use those boundaries as the `skip`, `n_max` and `col_types` arguments to `readxl::read_excel()`

1. Read the spreadsheet with `tidyxl::xlsx_cells()`. Filter the result for sentinel values, e.g. the cells containing the first and final column headers, and a cell in the final row of data.
2. Construct the arguments `skip`, `n_max` and `col_types` so that `readxl::read_excel()` gets the exact dimensions of the table.

```
# Step 1: read the spreadsheet and filter for sentinel values to detect the
# top-left and bottom-right cells
cells <- xlsx_cells(path, sheet = "notes")
rectify(cells)
```

```
## # A tibble: 7 x 5
##   `row/col` `1(A)`      `2(B)`   `3(C)` `4(D)`
##       <int> <chr>       <chr>    <chr>  <chr>
## 1         1 Title text  <NA>     <NA>   <NA>
## 2         2 <NA>        <NA>     <NA>   <NA>
## 3         3 <NA>        Name     Age    <NA>
## 4         4 <NA>        Matilda  1      <NA>
## 5         5 <NA>        Nicholas 3      <NA>
## 6         6 <NA>        <NA>     <NA>   <NA>
## 7         7 <NA>        <NA>     <NA>   Footnote
```

```
top_left <-
  dplyr::filter(cells, character == "Name") %>%
  select(row, col)
top_left
```

```
## # A tibble: 1 x 2
##     row   col
##   <int> <int>
## 1     3     2
```

```
# It can be tricky to find the bottom-right cell because you have to make some
# assumptions.  Here we assume that only cells within the table are numeric.
bottom_right <-
  dplyr::filter(cells, data_type == "numeric") %>%
  summarise(row = max(row), col = max(col))
bottom_right
```

```
## # A tibble: 1 x 2
##     row   col
##   <dbl> <dbl>
## 1     5     3
```

```
# Step 2: construct the arguments `skip` and `n_max` for read_excel()
skip <- top_left$row - 1L
n_rows <- bottom_right$row - skip

read_excel(path, sheet = "notes", skip = skip, n_max = n_rows)
```

```
## # A tibble: 2 x 2
##   Name       Age
##   <chr>    <dbl>
## 1 Matilda      1
## 2 Nicholas     3
```

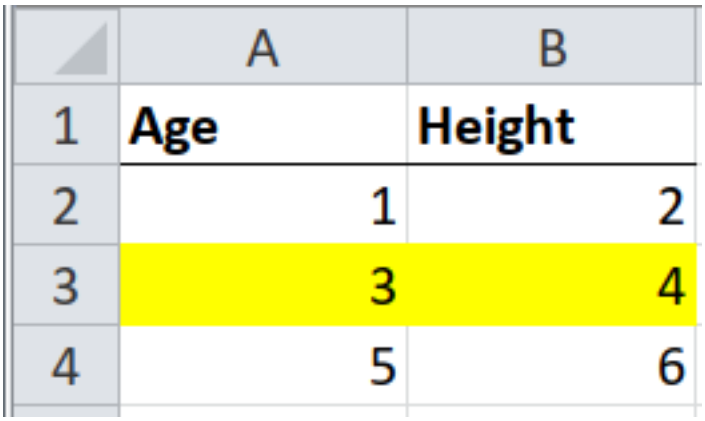
Here's another way using only tidyxl and unpivotr.

```
# Step 2: filter for cells between the top-left and bottom-right, and spatter
# into a table
cells %>%
  dplyr::filter(between(row, top_left$row, bottom_right$row),
         between(col, top_left$col, bottom_right$col)) %>%
```

```
  select(row, col, data_type, character, numeric) %>%
  behead("N", header) %>%
  select(-col) %>%
  spatter(header) %>%
  select(-row)
```

```
## # A tibble: 2 x 2
##     Age Name
##   <dbl> <chr>
## 1     1 Matilda
## 2     3 Nicholas
```

2.3 Meaningfully formatted rows



	A	B
1	Age	Height
2	1	2
3	3	4
4	5	6

As with clean, tidy tables, but with a second step to interpret the formatting.

Sometimes whole rows in a table are highlighted by formatting them with, say, a bright yellow fill. The highlighting could mean "this observation should be ignored", or "this product is no longer available". Different colours could mean different levels of a hierarchy, e.g. green for "pass" and red for "fail".

There are three steps to interpreting this.

1. Import the table, taking only the cell values and ignoring the formatting.
2. Import one column of the table, taking only the formatting and not the cell values.
3. Use `dplyr::bind_cols()` to append the column of formatting to the table of cell values. You can then interpret the formatting however you like.

Step 1 is the same as clean, tidy tables.

Step 2 uses `tidyxl::xlsx_cells()` to load the data, `tidyxl::xlsx_formats()`, and several tidyverse functions to link the two and filter for only one column. Why only one column? Because if a whole row is highlighted, then you only need to know the highlighting of one column to know the highlighting of all the others.

This is a special case of the following section, meaningfully formatted cells. Here `dplyr::bind_cols()` can be used as a shortcut, because we are joining exactly `n` rows of formatting to `n` rows of data. The following sections is a more general case that can be used instead of this procedure.

```
# Step 1: import the table taking only cell values and ignoring the formatting
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
x <- read_excel(path, sheet = "highlights")
```

```
# Step 2: import one column of the table, taking only the formatting and not the
# cell values

# `formats` is a pallette of fill colours that can be indexed by the
# `local_format_id` of a given cell to get the fill colour of that cell
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb

# Import all the cells, filter out the header row, filter for the first column,
# and create a new column `fill_colour` of the fill colours, by looking up the
# local_format_id of each cell in the `fill_colours` pallette.
fills <-
  xlsx_cells(path, sheet = "highlights") %>%
  dplyr::filter(row >= 2, col == 1) %>% # Omit the header row
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(fill_colour)

# Step 3: append the `fill` column to the rest of the data
bind_cols(x, fills) %>%
  select(Age, Height, fill_colour)
```

```
## # A tibble: 3 x 3
##     Age Height fill_colour
##   <dbl>  <dbl> <chr>
## 1     1      2 <NA>
## 2     3      4 FFFFFF00
## 3     5      6 <NA>
```

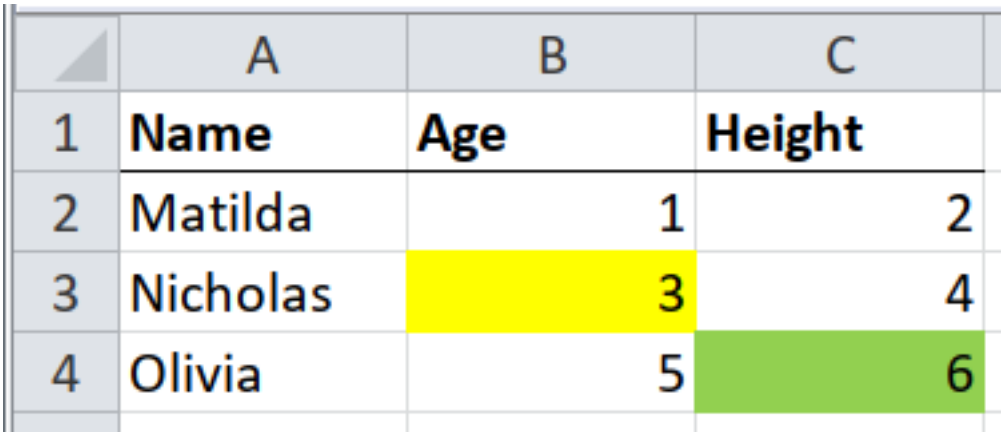
Note that the fill colour is expressed as an RGB value with transparency in the first two letters, e.g. `FFFFFF00` is `FF` (opaque), with `FFFF00` (yellow).

Here's another way using only tidyxl and unpivotr.

```
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb

xlsx_cells(path, sheet = "highlights") %>%
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(row, col, data_type, character, numeric, fill_colour) %>%
  behead("N", header) %>%
  select(-col, -character) %>%
  spatter(header) %>%
  select(-row)
```

```
## # A tibble: 3 x 3
##   fill_colour   Age Height
##   <chr>       <dbl>  <dbl>
## 1 <NA>            1      2
## 2 FFFFFF00        3      4
## 3 <NA>            5      6
```

2.4 Meaningfully formatted cells



	A	B	C
1	Name	Age	Height
2	Matilda	1	2
3	Nicholas	3	4
4	Olivia	5	6

If single cells are highlighted, rather than whole rows, then the highlights probably indicate something about the column rather than the row. For example, a highlighted cell in a column called "age" of a table of medical patients, might mean "the age of this patient is uncertain".

One way to deal with this is to create a new column in the final table for each column in the original that has any highlighted cells. For example, if highlighted cells mean "this value is uncertain", and some cells in the `age` and `height` columns are highlighted, then you could create two new columns: `uncertain_age`, and `uncertain_height`, by following the procedure of meaningfully formatted rows for each column `age` and `height`.

```
# Step 1: import the table taking only cell values and ignoring the formatting
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
x <- read_excel(path, sheet = "annotations")

# Step 2: import one column of the table, taking only the formatting and not the
# cell values

# `formats` is a pallette of fill colours that can be indexed by the
# `local_format_id` of a given cell to get the fill colour of that cell
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb

# Import all the cells, filter out the header row, filter for the first column,
# and create new columns `something_fill` of the fill colours, by looking up the
# local_format_id of each cell in the `formats` pallette.
fills <-
  xlsx_cells(path, sheet = "annotations") %>%
  dplyr::filter(row >= 2, col >= 2) %>% # Omit the header row and name column
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(row, col, fill_colour) %>%
  spread(col, fill_colour) %>%
  select(-row) %>%
  set_names(paste0(colnames(x)[-1], "_fill"))
fills
```

```
## # A tibble: 3 x 2
##   Age_fill Height_fill
##   <chr>    <chr>
## 1 <NA>     <NA>
## 2 FFFFFF00 <NA>
```

```
## 3 <NA>     FF92D050
```

```
# Step 3: append the `fill` column to the rest of the data
bind_cols(x, fills)
```

```
## # A tibble: 3 x 5
##   Name       Age Height Age_fill Height_fill
##   <chr>    <dbl>  <dbl> <chr>    <chr>
## 1 Matilda      1      2 <NA>     <NA>
## 2 Nicholas     3      4 FFFFFF00 <NA>
## 3 Olivia       5      6 <NA>     FF92D050
```

Here's the same thing, but using only tidyxl and unpivotr

```
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb

cells <-
  xlsx_cells(path, sheet = "annotations") %>%
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(row, col, data_type, character, numeric, fill_colour)
cells
```

```
## # A tibble: 12 x 6
##      row   col data_type character numeric fill_colour
##    <int> <int> <chr>     <chr>       <dbl> <chr>
##  1     1     1 character Name           NA <NA>
##  2     1     2 character Age            NA <NA>
##  3     1     3 character Height         NA <NA>
##  4     2     1 character Matilda        NA <NA>
##  5     2     2 numeric   <NA>            1 <NA>
##  6     2     3 numeric   <NA>            2 <NA>
##  7     3     1 character Nicholas       NA <NA>
##  8     3     2 numeric   <NA>            3 FFFFFF00
##  9     3     3 numeric   <NA>            4 <NA>
## 10     4     1 character Olivia         NA <NA>
## 11     4     2 numeric   <NA>            5 <NA>
## 12     4     3 numeric   <NA>            6 FF92D050
```

```
values <-
  cells %>%
  select(-fill_colour) %>%
  behead("N", header) %>%
  select(-col) %>%
  spatter(header)
values
```

```
## # A tibble: 3 x 4
##     row   Age Height Name
##   <int> <dbl>  <dbl> <chr>
## 1     2     1      2 Matilda
## 2     3     3      4 Nicholas
## 3     4     5      6 Olivia
```

```
fills <-
  cells %>%
  behead("N", header) %>%
  mutate(header = paste0(header, "_fill")) %>%
  select(row, header, fill_colour) %>%
```

```
  spread(header, fill_colour)
fills
```

```
## # A tibble: 3 x 4
##     row Age_fill Height_fill Name_fill
##   <int> <chr>    <chr>       <chr>
## 1     2 <NA>     <NA>        <NA>
## 2     3 FFFFFF00 <NA>        <NA>
## 3     4 <NA>     FF92D050    <NA>
```

```
left_join(values, fills, by = "row") %>%
  select(-row)
```

```
## # A tibble: 3 x 6
##     Age Height Name     Age_fill Height_fill Name_fill
##   <dbl>  <dbl> <chr>    <chr>    <chr>       <chr>
## 1     1      2 Matilda  <NA>     <NA>        <NA>
## 2     3      4 Nicholas FFFFFF00 <NA>        <NA>
## 3     5      6 Olivia   <NA>     FF92D050    <NA>
```

Another way would be to make the table what I call "extra-tidy". If it is tidy, then each row is an observation, and each column is a variable. To make it "extra-tidy", you `gather()` the variables so that each row is *one observation of one variable*. This works best when every variable has the same data type, otherwise the values will be coerced, probably to a character.

```
# Tidy
(x <- read_excel(path, sheet = "annotations"))
```

```
## # A tibble: 3 x 3
##   Name       Age Height
##   <chr>    <dbl>  <dbl>
## 1 Matilda      1      2
## 2 Nicholas     3      4
## 3 Olivia       5      6
```

```
# Extra-tidy
extra_tidy <-
  x %>%
  gather(variable, value, -Name) %>%
  arrange(Name, variable)
extra_tidy
```

```
## # A tibble: 6 x 3
##   Name     variable value
##   <chr>    <chr>    <dbl>
## 1 Matilda  Age          1
## 2 Matilda  Height       2
## 3 Nicholas Age          3
## 4 Nicholas Height       4
## 5 Olivia   Age          5
## 6 Olivia   Height       6
```

With an extra-tidy dataset, the formatting can now be appended to the values of individual variables, rather than to whole observations.

```
# Extra-tidy, with row and column numbers of the original variables
extra_tidy <-
  read_excel(path, sheet = "annotations") %>%
```

```
  mutate(row = row_number() + 1L) %>%
  gather(variable, value, -row, -Name) %>%
  group_by(row) %>%
  mutate(col = row_number() + 1L) %>%
  ungroup() %>%
  select(row, col, Name, variable, value) %>%
  arrange(row, col)
extra_tidy
```

```
## # A tibble: 6 x 5
##     row   col Name     variable value
##   <int> <int> <chr>    <chr>    <dbl>
## 1     2     2 Matilda  Age          1
## 2     2     3 Matilda  Height       2
## 3     3     2 Nicholas Age          3
## 4     3     3 Nicholas Height       4
## 5     4     2 Olivia   Age          5
## 6     4     3 Olivia   Height       6
```

```
# `formats` is a pallette of fill colours that can be indexed by the
# `local_format_id` of a given cell to get the fill colour of that cell
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb

# Import all the cells, filter out the header row, filter for the first column,
# and create a new column `uncertain` based on the fill colours, by looking up
# the local_format_id of each cell in the `formats` pallette.
fills <-
  xlsx_cells(path, sheet = "annotations") %>%
  dplyr::filter(row >= 2, col >= 2) %>% # Omit the header row and name column
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(row, col, fill_colour)
fills
```

```
## # A tibble: 6 x 3
##     row   col fill_colour
##   <int> <int> <chr>
## 1     2     2 <NA>
## 2     2     3 <NA>
## 3     3     2 FFFFFF00
## 4     3     3 <NA>
## 5     4     2 <NA>
## 6     4     3 FF92D050
```

```
# Step 3: append the `fill` column to the rest of the data
left_join(extra_tidy, fills, by = c("row", "col"))
```

```
## # A tibble: 6 x 6
##     row   col Name     variable value fill_colour
##   <int> <int> <chr>    <chr>    <dbl> <chr>
## 1     2     2 Matilda  Age          1 <NA>
## 2     2     3 Matilda  Height       2 <NA>
## 3     3     2 Nicholas Age          3 FFFFFF00
## 4     3     3 Nicholas Height       4 <NA>
## 5     4     2 Olivia   Age          5 <NA>
## 6     4     3 Olivia   Height       6 FF92D050
```

Here's the same extra-tidy version, but using only tidyxl and unpivotr.

```
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb

xlsx_cells(path, sheet = "annotations") %>%
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(row, col, data_type, character, numeric, fill_colour) %>%
  behead("W", Name) %>%
  behead("N", variable) %>%
  select(-data_type, -character, value = numeric)
```

```
## # A tibble: 6 x 6
##     row   col value fill_colour Name     variable
##   <int> <int> <dbl> <chr>       <chr>    <chr>
## 1     2     2     1 <NA>        Matilda  Age
## 2     2     3     2 <NA>        Matilda  Height
## 3     3     2     3 FFFFFF00    Nicholas Age
## 4     3     3     4 <NA>        Nicholas Height
## 5     4     2     5 <NA>        Olivia   Age
## 6     4     3     6 FF92D050    Olivia   Height
```

2.5 Layered meaningful formatting

	A	B	C
1	**Name**	**Weight**	**Price**
2	Knife	7	8
3	Fork	5	6
4	Spoon	3	4
5	Teaspoon	1	2

Sometimes different kinds of formatting relate to clearly different aspects of an observation, e.g. yellow highlight for "uncertain data" and red text for "product no longer available". Both yellow highlighting and red text in the same row would indicate uncertain data and unavailability of the product at the same time.

Deal with it by reading each kind of formatting into a separate column, e.g. fill colour into one column, font colour into another, bold/not-bold into a another, etc.

```
# Step 1: import the table taking only cell values and ignoring the formatting
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
x <- read_excel(path, sheet = "combined-highlights")

# Step 2: import one kind of formatting of one column of the table

# `formats` is a pallette of fill colours that can be indexed by the
```

```
# `local_format_id` of a given cell to get the fill colour of that cell
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb
font_colours <- xlsx_formats(path)$local$font$color$rgb

# Import all the cells, filter out the header row, filter for the first column,
# and create a new column `fill` of the fill colours, by looking up the
# local_format_id of each cell in the `formats` pallette.
formats <-
  xlsx_cells(path, sheet = "combined-highlights") %>%
  dplyr::filter(row >= 2, col == 1) %>% # Omit the header row
  mutate(fill_colour = fill_colours[local_format_id],
         font_colour = font_colours[local_format_id]) %>%
  select(fill_colour, font_colour)

# Step 3: append the `fill` column to the rest of the data
bind_cols(x, formats)
```

```
## # A tibble: 4 x 5
##   Name     Weight Price fill_colour font_colour
##   <chr>     <dbl> <dbl> <chr>       <chr>
## 1 Knife         7     8 <NA>        FF000000
## 2 Fork          5     6 FFFFFF00    FF000000
## 3 Spoon         3     4 <NA>        FFFF0000
## 4 Teaspoon      1     2 FFFFFF00    FFFF0000
```

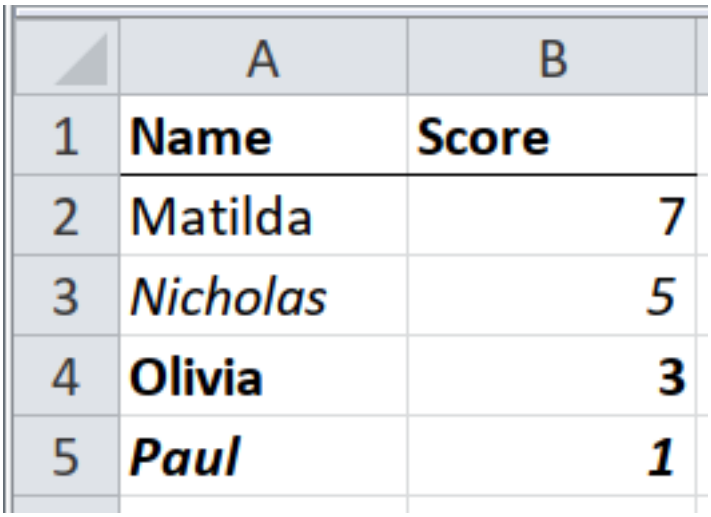
Here's the same thing, but using only tidyxl and unpivotr.

```
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb
font_colours <- xlsx_formats(path)$local$font$color$rgb

cells <-
  xlsx_cells(path, sheet = "combined-highlights") %>%
  mutate(fill_colour = fill_colours[local_format_id],
         font_colour = font_colours[local_format_id]) %>%
  select(row, col, data_type, character, numeric, fill_colour, font_colour) %>%
  behead("N", header) %>%
  behead("W", Name) %>%
  select(-col, -character)

values <-
  cells %>%
  select(-fill_colour, -font_colour) %>%
  spread(header, numeric)

formats <- distinct(cells, row, fill_colour, font_colour)

left_join(values, formats, by = "row") %>%
  select(-row)
```

```
## # A tibble: 4 x 6
##   data_type Name     Price Weight fill_colour font_colour
##   <chr>     <chr>    <dbl>  <dbl> <chr>       <chr>
## 1 numeric   Knife        8      7 <NA>        FF000000
## 2 numeric   Fork         6      5 FFFFFF00    <NA>
## 3 numeric   Spoon        4      3 <NA>        FFFF0000
```

```
## 4 numeric    Teaspoon     2       1 FFFFFF00    FFFF0000
```

2.6 Hierarchies in formatting



	A	B
1	**Name**	**Score**
2	Matilda	7
3	*Nicholas*	*5*
4	**Olivia**	**3**
5	***Paul***	***1***

Different kinds of formatting might also represent different levels of a hierarchy, e.g.

formatting	interpretation
none	good
italic	satisfactory
bold	poor
bold & italic	fail

When each kind of formatting relates to a different level of one hierarchy, import the different kinds of formatting into different columns, and then combine them into a third column, perhaps using `paste()`, or `case_when()`.

```
# Step 1: import the table taking only cell values and ignoring the formatting
x <- read_excel(path, sheet = "highlight-hierarchy")
x
```

```
## # A tibble: 4 x 2
##   Name     Score
##   <chr>    <dbl>
## 1 Matilda      7
## 2 Nicholas     5
## 3 Olivia       3
## 4 Paul         1
```

```
# Step 2: import one kind of formatting of one column of the table

# `formats` is a pallette of fill colours that can be indexed by the
# `local_format_id` of a given cell to get the fill colour of that cell
bold <- xlsx_formats(path)$local$font$bold
italic <- xlsx_formats(path)$local$font$italic

# Import all the cells, filter out the header row, filter for the first column,
```

```
# and create a new column `fill` of the fill colours, by looking up the
# local_format_id of each cell in the `formats` pallette.
formats <-
  xlsx_cells(path, sheet = "highlight-hierarchy") %>%
  dplyr::filter(row >= 2, col == 1) %>% # Omit the header row
  mutate(bold = bold[local_format_id],
         italic = italic[local_format_id]) %>%
  mutate(grade = case_when(bold & italic ~ "fail",
                           bold ~ "poor",
                           italic ~ "satisfactory",
                           TRUE ~ "good")) %>%
  select(bold, italic, grade)

# Step 3: append the `fill` column to the rest of the data
bind_cols(x, formats)
```

```
## # A tibble: 4 x 5
##   Name     Score bold  italic grade
##   <chr>    <dbl> <lgl> <lgl>  <chr>
## 1 Matilda      7 FALSE FALSE  good
## 2 Nicholas     5 FALSE TRUE   satisfactory
## 3 Olivia       3 TRUE  FALSE  poor
## 4 Paul         1 TRUE  TRUE   fail
```

Here it is again, using only tidyxl and unpivotr.

```
bold <- xlsx_formats(path)$local$font$bold
italic <- xlsx_formats(path)$local$font$italic

xlsx_cells(path, sheet = "highlight-hierarchy") %>%
  mutate(bold = bold[local_format_id],
         italic = italic[local_format_id]) %>%
  mutate(grade = case_when(bold & italic ~ "fail",
                           bold ~ "poor",
                           italic ~ "satisfactory",
                           TRUE ~ "good")) %>%
  select(row, col, data_type, character, numeric, bold, italic, grade) %>%
  behead("N", header) %>%
  select(-col) %>%
  spatter(header)
```

```
## # A tibble: 4 x 6
##     row bold  italic grade        Name     Score
##   <int> <lgl> <lgl>  <chr>        <chr>    <dbl>
## 1     2 FALSE FALSE  good         Matilda      7
## 2     3 FALSE TRUE   satisfactory Nicholas     5
## 3     4 TRUE  FALSE  poor         Olivia       3
## 4     5 TRUE  TRUE   fail         Paul         1
```

2.7 Sentinel values in non-text columns

	A	B	C
1	**Name**	**Subject**	**Score**
2	Matilda	Music	7
3	Nicholas	Classics	NA
4	Olivia	...	3
5	Paul	NA	..C

R packages like readr recognise `NA` as a sentinel value that means "Not Applicable", or "Not Available", or anything you want. It doesn't affect the data type of a column when `NA` is one of the values. Some datasets use other symbols as a sentinel value, e.g. `N/A` or `.`, or a combination, in which case you can instruct `readr` to interpret those values as sentinels, and it will import them all as `NA`.

But what if the data uses more than one *kind* of sentinel value. For example, Statistics New Zealand uses `...` to mean "Not applicable", and `..C` to mean "Confidentialised". Most tools will either regard both values as `NA`, or coerce the whole column to characters.

```
read_csv("a, b,   c
          1, 2,   3
          4, ..., ..C",
         na = c("...", "..C")) # Regard both values as NA
```

```
## # A tibble: 2 x 3
##       a     b     c
##   <dbl> <dbl> <dbl>
## 1     1     2     3
## 2     4    NA    NA
```

```
read_csv("a, b,   c
          1, 2,   3
          4, ..., ..C",
         na = "")              # Coerce the whole column to characters
```

```
## # A tibble: 2 x 3
##       a b     c
##   <dbl> <chr> <chr>
## 1     1 2     3
## 2     4 ...     ..C
```

A better procedure is to import the sentinel values into their own column, or even into separate `TRUE`/`FALSE` columns for each kind of sentinel.

Note that sentinel values relate the the value in the cell, rather than to the whole row, so the first step is to make the dataset *extra-tidy* as in the section "Already a tidy table but with meaningful formatting of single cells".

```
# Tidy
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
x <- read_excel(path, sheet = "sentinels")
x
```

```
## # A tibble: 4 x 3
##   Name     Subject  Score
##   <chr>    <chr>    <chr>
## 1 Matilda  Music    7
## 2 Nicholas Classics NA
## 3 Olivia   ...        3
## 4 Paul     NA       ..C
```

```
# Extra-tidy
extra_tidy <-
  gather(x, variable, value, -Name) %>%
  arrange(Name, variable)
extra_tidy
```

```
## # A tibble: 8 x 3
##   Name     variable value
##   <chr>    <chr>    <chr>
## 1 Matilda  Score    7
## 2 Matilda  Subject  Music
## 3 Nicholas Score    NA
## 4 Nicholas Subject  Classics
## 5 Olivia   Score    3
## 6 Olivia   Subject  ...
## 7 Paul     Score    ..C
## 8 Paul     Subject  NA
```

With an extra-tidy dataset, the sentinels can now be appended to the values of individual variables, rather than to whole observations.

```
# Extra-tidy, with row and column numbers of the original variables, and the
# sentinels omitted
extra_tidy <-
  read_excel(path, sheet = "sentinels", na = c("NA", "...", "..C")) %>%
  mutate(row = row_number() + 1L) %>%
  gather(variable, value, -row, -Name) %>%
  group_by(row) %>%
  mutate(col = row_number() + 1L) %>%
  ungroup() %>%
  select(row, col, Name, variable, value) %>%
  arrange(row, col)
extra_tidy
```

```
## # A tibble: 8 x 5
##     row   col Name     variable value
##   <int> <int> <chr>    <chr>    <chr>
## 1     2     2 Matilda  Subject  Music
## 2     2     3 Matilda  Score    7
## 3     3     2 Nicholas Subject  Classics
## 4     3     3 Nicholas Score    <NA>
## 5     4     2 Olivia   Subject  <NA>
## 6     4     3 Olivia   Score    3
```

```
## 7     5     2 Paul     Subject  <NA>
## 8     5     3 Paul     Score    <NA>
```

```
# Import all the cells, and filter for sentinel values
sentinels <-
  xlsx_cells(path, sheet = "sentinels") %>%
  dplyr::filter(character %in% c("NA", "...", "..C")) %>%
  mutate(sentinel = character) %>%
  select(row, col, sentinel)
sentinels
```

```
## # A tibble: 4 x 3
##     row   col sentinel
##   <int> <int> <chr>
## 1     3     3 NA
## 2     4     2 ...
## 3     5     2 NA
## 4     5     3 ..C
```

```
# Join the `sentinel` column to the rest of the data
left_join(extra_tidy, sentinels, by = c("row", "col"))
```

```
## # A tibble: 8 x 6
##     row   col Name     variable value    sentinel
##   <int> <int> <chr>    <chr>    <chr>    <chr>
## 1     2     2 Matilda  Subject  Music    <NA>
## 2     2     3 Matilda  Score    7        <NA>
## 3     3     2 Nicholas Subject  Classics <NA>
## 4     3     3 Nicholas Score    <NA>     NA
## 5     4     2 Olivia   Subject  <NA>     ...
## 6     4     3 Olivia   Score    3        <NA>
## 7     5     2 Paul     Subject  <NA>     NA
## 8     5     3 Paul     Score    <NA>     ..C
```

Here's another version using only tidyxl and unpivotr, which provides `isolate_sentinels()` to make this much more straightforward.

```
xlsx_cells(path, sheet = "sentinels") %>%
  select(row, col, data_type, character, numeric) %>%
  isolate_sentinels(character, c("NA", "...", "..C")) %>%
  behead("W", Name) %>%
  behead("N", variable) %>%
  select(Name, variable, character, numeric, sentinel)
```

```
## # A tibble: 8 x 5
##   Name     variable character numeric sentinel
##   <chr>    <chr>    <chr>       <dbl> <chr>
## 1 Matilda  Subject  Music          NA <NA>
## 2 Matilda  Score    <NA>            7 <NA>
## 3 Nicholas Subject  Classics       NA <NA>
## 4 Nicholas Score    <NA>           NA NA
## 5 Olivia   Subject  <NA>           NA ...
## 6 Olivia   Score    <NA>            3 <NA>
## 7 Paul     Subject  <NA>           NA NA
## 8 Paul     Score    <NA>           NA ..C
```

Chapter 3

Pivot tables

	A	B	C	D	E	F	G
1							
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

This part introduces pivot tables. Tidyxl and unpivotr come into their own here, and are (as far as I know) the only the only packages to acknowledge the intuitive grammar of pivot tables.

Pivot tables are ones with more than one row of column headers, or more than one column of row headers, or both (and there can be more complex arrangements). Tables in that form take up less space on a page or a screen than 'tidy' tables, and are easier for humans to read. But most software can't interpret or traverse data in that form; it must first be reshaped into a long, 'tidy' form, with a single row of column headers.

It takes a lot of code to reshape a pivot table into a 'tidy' one, and the code has to be bespoke for each table. There's no general solution, because it is ambiguous whether a given cell is part of a header or part of the data.

There are some ambiguities in 'tidy' tables, too, which is why most functions for reading csv files allow you to specify whether the first row of the data is a header, and how many rows to skip before the data begins. Functions often guess, but they can never be certain.

Pivot tables, being more complex, are so much more ambiguous that it isn't reasonable to import them with a single function. A better way is to break the problem down into steps:

1. Identify which cells are headers, and which are data.
2. State how the data cells relate to the header cells.

The first step is a matter of traversing the cells, which is *much easier* if you load them with the tidyxl package, or pass the table through `as_cells()` in the unpivotr package. This gives you a table of cells and their properties; one row of the table describes one cell of the source table or spreadsheet. The first two properties are the row and column position of the cell, which makes it easy to filter for cells in a particular region of the spreadsheet. If the first row of cells is a header row, then you can filter for `row == 1`.

Here is an example of a pivot table where the first two rows, and the first two columns, are headers. The other cells contain the data. First, see how the cells are laid out in the source file by importing it with readxl.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
original <- read_excel(path, sheet = "pivot-annotations", col_names = FALSE)
print(original, n = Inf)
```

```
## # A tibble: 6 x 6
##   X__1        X__2     X__3    X__4   X__5     X__6
##   <chr>       <chr>    <chr>   <chr>  <chr>    <chr>
## 1 <NA>        <NA>     Female  <NA>   Male     <NA>
## 2 <NA>        <NA>     Matilda Olivia Nicholas Paul
## 3 Humanities  Classics 1       2      3        0
## 4 <NA>        History  3       4      5        1
## 5 Performance Music    5       6      9        2
## 6 <NA>        Drama    7       8      12       3
```

Compare that with the long set of cells, one per row, that tidyxl gives. (Only a few properties of each cell are shown, to make it easier to read).

```
cells <- xlsx_cells(path, sheets = "pivot-annotations")
select(cells, row, col, data_type, character, numeric) %>%
  print(cells, n = 20)
```

```
## # A tibble: 32 x 5
##      row   col data_type character  numeric
##    <int> <int> <chr>     <chr>        <dbl>
##  1     2     4 character Female          NA
##  2     2     5 blank     <NA>            NA
##  3     2     6 character Male            NA
##  4     2     7 blank     <NA>            NA
##  5     3     4 character Matilda         NA
##  6     3     5 character Olivia          NA
##  7     3     6 character Nicholas        NA
##  8     3     7 character Paul            NA
##  9     4     2 character Humanities      NA
## 10     4     3 character Classics        NA
## 11     4     4 numeric   <NA>             1
## 12     4     5 numeric   <NA>             2
## 13     4     6 numeric   <NA>             3
## 14     4     7 numeric   <NA>             0
## 15     5     2 blank     <NA>            NA
## 16     5     3 character History         NA
## 17     5     4 numeric   <NA>             3
## 18     5     5 numeric   <NA>             4
## 19     5     6 numeric   <NA>             5
## 20     5     7 numeric   <NA>             1
## # ... with 12 more rows
```

A similar result is obtained via `unpivotr::as_cells()`.

```
original <- read_excel(path, sheet = "pivot-annotations", col_names = FALSE)
as_cells(original) %>%
  arrange(row, col) %>%
  print(n = 20)
```

```
## # A tibble: 36 x 4
```

```
##      row   col data_type chr
##    <int> <int> <chr>     <chr>
##  1     1     1 chr       <NA>
##  2     1     2 chr       <NA>
##  3     1     3 chr       Female
##  4     1     4 chr       <NA>
##  5     1     5 chr       Male
##  6     1     6 chr       <NA>
##  7     2     1 chr       <NA>
##  8     2     2 chr       <NA>
##  9     2     3 chr       Matilda
## 10     2     4 chr       Olivia
## 11     2     5 chr       Nicholas
## 12     2     6 chr       Paul
## 13     3     1 chr       Humanities
## 14     3     2 chr       Classics
## 15     3     3 chr       1
## 16     3     4 chr       2
## 17     3     5 chr       3
## 18     3     6 chr       0
## 19     4     1 chr       <NA>
## 20     4     2 chr       History
## # ... with 16 more rows
```

(One difference is that `read_excel()` has filled in some missing cells with blanks, which `as_cells()` retains. Another is that `read_excel()` has coerced all data types to `character`, whereas `xlsx_cells()` preserved the original data types.)

The tidyxl version is easier to traverse, because it describes the position of each cell as well as the value. To filter for the first row of headers:

```
dplyr::filter(cells, row == 2, !is_blank) %>%
  select(row, col, character, numeric)
```

```
## # A tibble: 2 x 4
##     row   col character numeric
##   <int> <int> <chr>       <dbl>
## 1     2     4 Female         NA
## 2     2     6 Male           NA
```

Or to filter for cells containing data (in this case, we know that only data cells are numeric)

```
dplyr::filter(cells, data_type == "numeric") %>%
  select(row, col, numeric)
```

```
## # A tibble: 16 x 3
##      row   col numeric
##    <int> <int>   <dbl>
##  1     4     4       1
##  2     4     5       2
##  3     4     6       3
##  4     4     7       0
##  5     5     4       3
##  6     5     5       4
##  7     5     6       5
##  8     5     7       1
##  9     6     4       5
```

```
## 10     6     5       6
## 11     6     6       9
## 12     6     7       2
## 13     7     4       7
## 14     7     5       8
## 15     7     6      12
## 16     7     7       3
```

By identifying the header cells separately from the data cells, and knowing exactly where they are on the sheet, we can associated the data cells with the relevant headers.

To a human it is intuitive that the cells below and to the right of the header `Male` represent males, and that ones to the right of and below the header `Postgraduate qualification` represent people with postgraduate qualifications, but it isn't so obvious to the computer. How would the computer know that the header `Male` doesn't also relate to the column of cells below and to the left, beginning with `2`?

This section shows how you can express the relationships between headers and data cells, using the unpivotr package.

3.1 Simple unpivoting

The `behead()` function takes one level of headers from a pivot table and makes it part of the data. Think of it like `tidyr::gather()`, except that it works when there is more than one row of headers (or more than one column of row-headers), and it only works on tables that have first come through `as_cells()` or `tidyxl::xlsx_cells()`.

3.1.1 Two clear rows of text column headers, left-aligned

	A	B	C	D	E	F	G
1							
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

Here we have a pivot table with two rows of column headers. The first row of headers is left-aligned, so `"Female"` applies to the first two columns of data, and `"Male"` applies to the next two. The second row of headers has a header in every column.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(col >= 4, !is_blank) %>% # Ignore the row headers in this example
  select(row, col, data_type, character, numeric)
all_cells
```

```
## # A tibble: 22 x 5
##      row   col data_type character numeric
```

```
##    <int> <int> <chr>     <chr>       <dbl>
##  1     2     4 character Female         NA
##  2     2     6 character Male           NA
##  3     3     4 character Matilda        NA
##  4     3     5 character Olivia         NA
##  5     3     6 character Nicholas       NA
##  6     3     7 character Paul           NA
##  7     4     4 numeric   <NA>            1
##  8     4     5 numeric   <NA>            2
##  9     4     6 numeric   <NA>            3
## 10     4     7 numeric   <NA>            0
## # ... with 12 more rows
```

The `behead()` function takes the 'melted' output of `as_cells()`, `tidyxl::xlsx_cells()`, or a previous `behead()`, and three more arguments to specify how the header cells relate to the data cells.

The outermost header is the top row, `"Female" NA "Male" NA`. The `"Female"` and `"Male"` headers are above and to-the-left-of the data cells. We express this as a compass direction, north-north-west, or `"NNW"`. We also give the headers a name, `sex`, and say which column of `all_cells` contains the value of the header cells – it's usually the `character` column.

```
all_cells %>%
  behead("NNW", sex)
```

```
## # A tibble: 20 x 6
##      row   col data_type character numeric sex
##    <int> <int> <chr>     <chr>       <dbl> <chr>
##  1     3     4 character Matilda        NA Female
##  2     3     5 character Olivia         NA Female
##  3     4     4 numeric   <NA>            1 Female
##  4     4     5 numeric   <NA>            2 Female
##  5     5     4 numeric   <NA>            3 Female
##  6     5     5 numeric   <NA>            4 Female
##  7     6     4 numeric   <NA>            5 Female
##  8     6     5 numeric   <NA>            6 Female
##  9     7     4 numeric   <NA>            7 Female
## 10     7     5 numeric   <NA>            8 Female
## 11     3     6 character Nicholas       NA Male
## 12     3     7 character Paul           NA Male
## 13     4     6 numeric   <NA>            3 Male
## 14     4     7 numeric   <NA>            0 Male
## 15     5     6 numeric   <NA>            5 Male
## 16     5     7 numeric   <NA>            1 Male
## 17     6     6 numeric   <NA>            9 Male
## 18     6     7 numeric   <NA>            2 Male
## 19     7     6 numeric   <NA>           12 Male
## 20     7     7 numeric   <NA>            3 Male
```

That did half the job. The value 2 in row 4 column 5 is indeed a score of a female. But the value `"matilda"` in row 3 column 4 isn't a population – it's another header. The next step is to strip that second level of column headers. This time, the compass direction is `"N"`, because the headers are directly above the associated data cells, and we call it `name`, because it represents names of people.

```
all_cells %>%
  behead("NNW", sex) %>%
  behead("N", `name`)
```

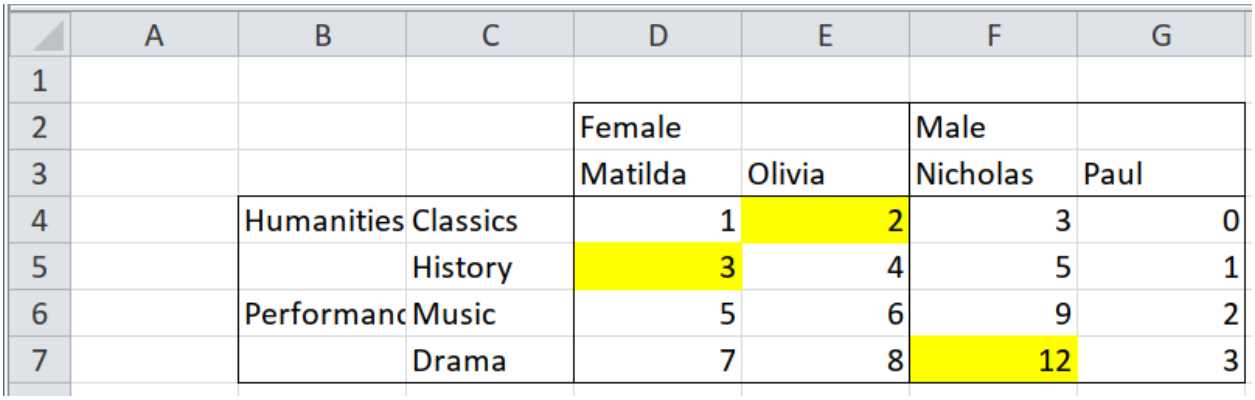
```
## # A tibble: 16 x 7
##      row   col data_type character numeric sex    name
##    <int> <int> <chr>     <chr>       <dbl> <chr>  <chr>
##  1     4     4 numeric   <NA>            1 Female Matilda
##  2     4     5 numeric   <NA>            2 Female Olivia
##  3     5     4 numeric   <NA>            3 Female Matilda
##  4     5     5 numeric   <NA>            4 Female Olivia
##  5     6     4 numeric   <NA>            5 Female Matilda
##  6     6     5 numeric   <NA>            6 Female Olivia
##  7     7     4 numeric   <NA>            7 Female Matilda
##  8     7     5 numeric   <NA>            8 Female Olivia
##  9     4     6 numeric   <NA>            3 Male   Nicholas
## 10     4     7 numeric   <NA>            0 Male   Paul
## 11     5     6 numeric   <NA>            5 Male   Nicholas
## 12     5     7 numeric   <NA>            1 Male   Paul
## 13     6     6 numeric   <NA>            9 Male   Nicholas
## 14     6     7 numeric   <NA>            2 Male   Paul
## 15     7     6 numeric   <NA>           12 Male   Nicholas
## 16     7     7 numeric   <NA>            3 Male   Paul
```

A final step is a normal clean-up. We drop the `row`, `col` and `character` columns, and we rename the `numeric` column to `score`, which is what it represents.

```
all_cells %>%
  behead("NNW", sex) %>%
  behead("N", `name`) %>%
  select(score = numeric, sex, `name`)
```

```
## # A tibble: 16 x 3
##    score sex    name
##    <dbl> <chr>  <chr>
##  1     1 Female Matilda
##  2     2 Female Olivia
##  3     3 Female Matilda
##  4     4 Female Olivia
##  5     5 Female Matilda
##  6     6 Female Olivia
##  7     7 Female Matilda
##  8     8 Female Olivia
##  9     3 Male   Nicholas
## 10     0 Male   Paul
## 11     5 Male   Nicholas
## 12     1 Male   Paul
## 13     9 Male   Nicholas
## 14     2 Male   Paul
## 15    12 Male   Nicholas
## 16     3 Male   Paul
```

3.1.2 Two clear rows and columns of text headers, top-aligned and left-aligned



1						
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

There are no new techniques are used, just more compass directions: `"W"` for headers directly to the left of the data cells, and `"WNW"` for headers left-and-above the data cells.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric) %>%
  print()
```

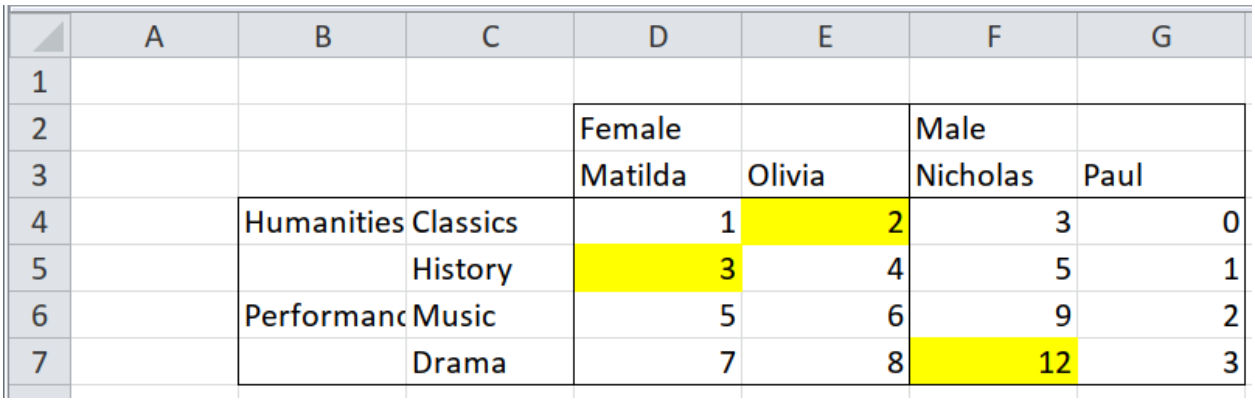
```
## # A tibble: 28 x 5
##      row   col data_type character  numeric
##    <int> <int> <chr>     <chr>        <dbl>
##  1     2     4 character Female          NA
##  2     2     6 character Male            NA
##  3     3     4 character Matilda         NA
##  4     3     5 character Olivia          NA
##  5     3     6 character Nicholas        NA
##  6     3     7 character Paul            NA
##  7     4     2 character Humanities      NA
##  8     4     3 character Classics        NA
##  9     4     4 numeric   <NA>             1
## 10     4     5 numeric   <NA>             2
## # ... with 18 more rows
```

```
all_cells %>%
  behead("NNW", sex) %>%   # As before
  behead("N", `name`) %>%  # As before
  behead("WNW", field) %>% # Left-and-above
  behead("W", subject) %>% # Directly left
  rename(score = numeric) %>%
  select(-row, -col, -character)
```

```
## # A tibble: 16 x 6
##    data_type score sex    name     field       subject
##    <chr>     <dbl> <chr>  <chr>    <chr>       <chr>
##  1 numeric       1 Female Matilda  Humanities  Classics
##  2 numeric       2 Female Olivia   Humanities  Classics
##  3 numeric       3 Female Matilda  Humanities  History
##  4 numeric       4 Female Olivia   Humanities  History
```

```
##  5 numeric       3 Male   Nicholas Humanities  Classics
##  6 numeric       0 Male   Paul     Humanities  Classics
##  7 numeric       5 Male   Nicholas Humanities  History
##  8 numeric       1 Male   Paul     Humanities  History
##  9 numeric       5 Female Matilda  Performance Music
## 10 numeric       6 Female Olivia   Performance Music
## 11 numeric       7 Female Matilda  Performance Drama
## 12 numeric       8 Female Olivia   Performance Drama
## 13 numeric       9 Male   Nicholas Performance Music
## 14 numeric       2 Male   Paul     Performance Music
## 15 numeric      12 Male   Nicholas Performance Drama
## 16 numeric       3 Male   Paul     Performance Drama
```

3.1.3 Multiple rows or columns of headers, with meaningful formatting



	A	B	C	D	E	F	G
1							
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

This is a combination of the previous section with meaningfully formatted rows. The section meaninfully formatted cells doesn't work here, because the unpivoting of multiple rows/columns of headers complicates the relationship between the data and the formatting.

1. Unpivot the multiple rows/columns of headers, as above, but keep the `row` and `col` of each data cell.
2. Collect the `row`, `col` and formatting of each data cell.
3. Join the data to the formatting by the `row` and `col`.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric) %>%
  print()
```

```
## # A tibble: 28 x 5
##      row   col data_type character  numeric
##    <int> <int> <chr>     <chr>        <dbl>
##  1     2     4 character Female          NA
##  2     2     6 character Male            NA
##  3     3     4 character Matilda         NA
##  4     3     5 character Olivia          NA
##  5     3     6 character Nicholas        NA
##  6     3     7 character Paul            NA
##  7     4     2 character Humanities      NA
##  8     4     3 character Classics        NA
```

```
##  9     4     4 numeric   <NA>             1
## 10     4     5 numeric   <NA>             2
## # ... with 18 more rows
```

```
unpivoted <-
  all_cells %>%
  behead("NNW", sex) %>%   # As before
  behead("N", `name`) %>%  # As before
  behead("WNW", field) %>% # Left-and-above
  behead("W", subject) %>% # Directly left
  rename(score = numeric) %>%
  select(-character)               # Retain the row and col for now
unpivoted
```

```
## # A tibble: 16 x 8
##      row   col data_type score sex    name     field       subject
##    <int> <int> <chr>     <dbl> <chr>  <chr>    <chr>       <chr>
##  1     4     4 numeric       1 Female Matilda  Humanities  Classics
##  2     4     5 numeric       2 Female Olivia   Humanities  Classics
##  3     5     4 numeric       3 Female Matilda  Humanities  History
##  4     5     5 numeric       4 Female Olivia   Humanities  History
##  5     4     6 numeric       3 Male   Nicholas Humanities  Classics
##  6     4     7 numeric       0 Male   Paul     Humanities  Classics
##  7     5     6 numeric       5 Male   Nicholas Humanities  History
##  8     5     7 numeric       1 Male   Paul     Humanities  History
##  9     6     4 numeric       5 Female Matilda  Performance Music
## 10     6     5 numeric       6 Female Olivia   Performance Music
## 11     7     4 numeric       7 Female Matilda  Performance Drama
## 12     7     5 numeric       8 Female Olivia   Performance Drama
## 13     6     6 numeric       9 Male   Nicholas Performance Music
## 14     6     7 numeric       2 Male   Paul     Performance Music
## 15     7     6 numeric      12 Male   Nicholas Performance Drama
## 16     7     7 numeric       3 Male   Paul     Performance Drama
```

```
# `formats` is a pallette of fill colours that can be indexed by the
# `local_format_id` of a given cell to get the fill colour of that cell
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb
fill_colours
```

```
##  [1] NA         NA         NA         NA         NA         NA
##  [7] NA         NA         "FFFFFF00" "FF92D050" "FFFFFF00" NA
## [13] NA         "FFFFFF00" NA         NA         NA         NA
## [19] NA         NA         NA         "FFFFFF00" "FFFFFF00" NA
## [25] NA         "FFFFFF00" NA         NA         NA         NA
## [31] NA         NA         NA         NA         NA         NA
## [37] NA         NA         NA         NA         NA         NA
## [43] NA         NA         NA         NA         NA         NA
## [49] NA         NA         NA         NA         NA         NA
## [55] NA         NA         "FFFFC7CE" NA         NA
```

```
# Import all the cells, filter out the header row, filter for the first column,
# and create a new column `approximate` based on the fill colours, by looking up
# the local_format_id of each cell in the `formats` pallette.
annotations <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(row >= 4, col >= 4) %>% # Omit the headers
```

```
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(row, col, fill_colour)
annotations
```

```
## # A tibble: 16 x 3
##      row   col fill_colour
##    <int> <int> <chr>
##  1     4     4 <NA>
##  2     4     5 FFFFFF00
##  3     4     6 <NA>
##  4     4     7 <NA>
##  5     5     4 FFFFFF00
##  6     5     5 <NA>
##  7     5     6 <NA>
##  8     5     7 <NA>
##  9     6     4 <NA>
## 10     6     5 <NA>
## 11     6     6 <NA>
## 12     6     7 <NA>
## 13     7     4 <NA>
## 14     7     5 <NA>
## 15     7     6 FFFFFF00
## 16     7     7 <NA>
```

```
left_join(unpivoted, annotations, by = c("row", "col")) %>%
  select(-row, -col)
```

```
## # A tibble: 16 x 7
##    data_type score sex    name     field       subject  fill_colour
##    <chr>     <dbl> <chr>  <chr>    <chr>       <chr>    <chr>
##  1 numeric       1 Female Matilda  Humanities  Classics <NA>
##  2 numeric       2 Female Olivia   Humanities  Classics FFFFFF00
##  3 numeric       3 Female Matilda  Humanities  History  FFFFFF00
##  4 numeric       4 Female Olivia   Humanities  History  <NA>
##  5 numeric       3 Male   Nicholas Humanities  Classics <NA>
##  6 numeric       0 Male   Paul     Humanities  Classics <NA>
##  7 numeric       5 Male   Nicholas Humanities  History  <NA>
##  8 numeric       1 Male   Paul     Humanities  History  <NA>
##  9 numeric       5 Female Matilda  Performance Music    <NA>
## 10 numeric       6 Female Olivia   Performance Music    <NA>
## 11 numeric       7 Female Matilda  Performance Drama    <NA>
## 12 numeric       8 Female Olivia   Performance Drama    <NA>
## 13 numeric       9 Male   Nicholas Performance Music    <NA>
## 14 numeric       2 Male   Paul     Performance Music    <NA>
## 15 numeric      12 Male   Nicholas Performance Drama    FFFFFF00
## 16 numeric       3 Male   Paul     Performance Drama    <NA>
```

3.2 Complex unpivoting

When `behead()` isn't powerful enough (it makes certain assumptions, and it doesn't understand formatting), then you can get much more control by using `enhead()`, which joins together two separate data frames of data cells and header cells.

This kind of unpivoting is always done in two stages.

1. Identify which cells are headers, and which are data
2. State how the data cells relate to the header cells.

3.2.1 Two clear rows of text column headers, left-aligned {#2RL}

	A	B	C	D	E	F	G
1							
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

The first stage, identifying header vs data cells, is simply filtering.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(col >= 4, !is_blank) %>% # Ignore the row headers in this example
  select(row, col, data_type, character, numeric) %>%
  print()
```

```
## # A tibble: 22 x 5
##      row   col data_type character numeric
##    <int> <int> <chr>     <chr>       <dbl>
##  1     2     4 character Female         NA
##  2     2     6 character Male           NA
##  3     3     4 character Matilda        NA
##  4     3     5 character Olivia         NA
##  5     3     6 character Nicholas       NA
##  6     3     7 character Paul           NA
##  7     4     4 numeric   <NA>            1
##  8     4     5 numeric   <NA>            2
##  9     4     6 numeric   <NA>            3
## 10     4     7 numeric   <NA>            0
## # ... with 12 more rows
```

```
# View the cells in their original positions on the spreadsheet
rectify(all_cells)
```

```
## # A tibble: 6 x 5
##   `row/col` `4(D)`  `5(E)` `6(F)`   `7(G)`
##       <int> <chr>   <chr>  <chr>    <chr>
## 1         2 Female  <NA>   Male     <NA>
## 2         3 Matilda Olivia Nicholas Paul
## 3         4 1       2      3        0
## 4         5 3       4      5        1
## 5         6 5       6      9        2
## 6         7 7       8      12       3
```

```
first_header_row <-
  dplyr::filter(all_cells, row == 2) %>%
  select(row, col, sex = character)
  # the title of this header is 'sex'
  # the cells are text cells (`"Female"` and `"Male"`) so take the value in the
  # ``character` column.
first_header_row
```

```
## # A tibble: 2 x 3
##     row   col sex
##   <int> <int> <chr>
## 1     2     4 Female
## 2     2     6 Male
```

```
second_header_row <-
  dplyr::filter(all_cells, row == 3) %>%
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the ``character` column.
second_header_row
```

```
## # A tibble: 4 x 3
##     row   col name
##   <int> <int> <chr>
## 1     3     4 Matilda
## 2     3     5 Olivia
## 3     3     6 Nicholas
## 4     3     7 Paul
```

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is exam scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`
```

The second stage is to declare how the data cells relate to each row of column headers. Unpivotr provides a set of functions for this, derived from the points of the compass.

Starting from the point of view of a data cell, the relevant column header from the second row of headers is the one directly north (up), or `"N"`.

```
enhead(data_cells, second_header_row, "N")
```

```
## # A tibble: 16 x 4
##      row   col score name
##    <int> <int> <dbl> <chr>
##  1     4     4     1 Matilda
##  2     4     5     2 Olivia
##  3     4     6     3 Nicholas
##  4     4     7     0 Paul
##  5     5     4     3 Matilda
##  6     5     5     4 Olivia
##  7     5     6     5 Nicholas
##  8     5     7     1 Paul
##  9     6     4     5 Matilda
```

```
## 10     6     5     6 Olivia
## 11     6     6     9 Nicholas
## 12     6     7     2 Paul
## 13     7     4     7 Matilda
## 14     7     5     8 Olivia
## 15     7     6    12 Nicholas
## 16     7     7     3 Paul
```

The first row of headers, from the point of view of a data cell, is either directly north (up), or north and west (up and left), or `"NNW"`.

```
enhead(data_cells, first_header_row, "NNW")
```

```
## # A tibble: 16 x 4
##      row   col score sex
##    <int> <int> <dbl> <chr>
##  1     4     4     1 Female
##  2     4     5     2 Female
##  3     5     4     3 Female
##  4     5     5     4 Female
##  5     6     4     5 Female
##  6     6     5     6 Female
##  7     7     4     7 Female
##  8     7     5     8 Female
##  9     4     6     3 Male
## 10     4     7     0 Male
## 11     5     6     5 Male
## 12     5     7     1 Male
## 13     6     6     9 Male
## 14     6     7     2 Male
## 15     7     6    12 Male
## 16     7     7     3 Male
```

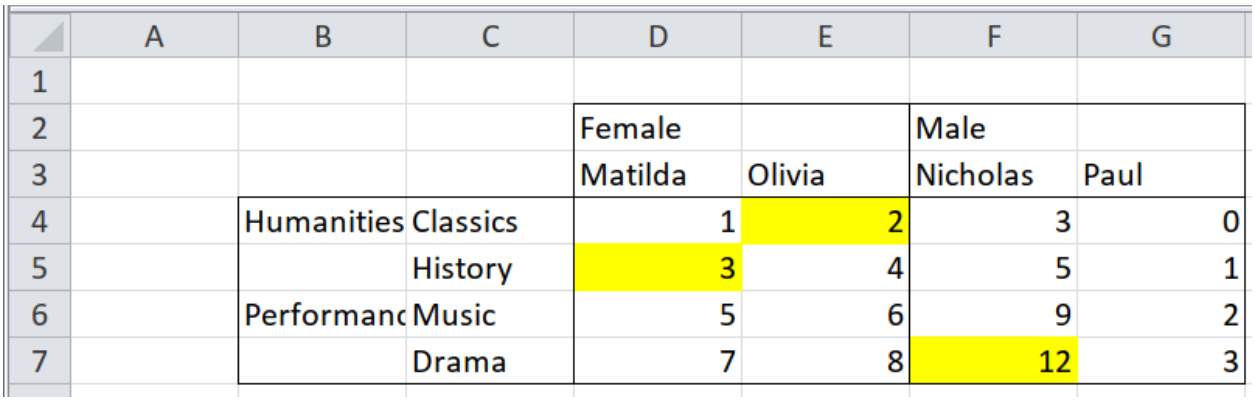
Piping everything together, we get a complete, tidy dataset, and can finally drop the `row` and `col` columns.

```
data_cells %>%
  enhead(first_header_row, "NNW") %>%
  enhead(second_header_row, "N") %>%
  select(-row, -col)
```

```
## # A tibble: 16 x 3
##    score sex    name
##    <dbl> <chr>  <chr>
##  1     1 Female Matilda
##  2     2 Female Olivia
##  3     3 Female Matilda
##  4     4 Female Olivia
##  5     5 Female Matilda
##  6     6 Female Olivia
##  7     7 Female Matilda
##  8     8 Female Olivia
##  9     3 Male   Nicholas
## 10     0 Male   Paul
## 11     5 Male   Nicholas
## 12     1 Male   Paul
## 13     9 Male   Nicholas
```

```
## 14     2 Male   Paul
## 15    12 Male   Nicholas
## 16     3 Male   Paul
```

3.2.2 Two clear columns of text row headers, top-aligned



	A	B	C	D	E	F	G
1							
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

This is almost the same as Two clear rows of text column headers, left-aligned, but with different compass directions: `"W"` for directly west (left), and `"WNW"` for west and north (left and up).

(`"NNW"` and `"WNW"` look like synonyms. They happen to be synonyms in `enhead()`, but they aren't in `behead()`.

In this example, the table has no column headers, only row headers. This is artificial here, but sometimes table are deliberately laid out in transpose form: the first column contains the headers, and the data extends in columns from left to right instead of from top to bottom.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(row >= 3, !is_blank) %>% # Ignore the column headers in this example
  select(row, col, data_type, character, numeric) %>%
  print()
```

```
## # A tibble: 26 x 5
##      row   col data_type character  numeric
##    <int> <int> <chr>     <chr>        <dbl>
##  1     3     4 character Matilda         NA
##  2     3     5 character Olivia          NA
##  3     3     6 character Nicholas        NA
##  4     3     7 character Paul            NA
##  5     4     2 character Humanities      NA
##  6     4     3 character Classics        NA
##  7     4     4 numeric   <NA>             1
##  8     4     5 numeric   <NA>             2
##  9     4     6 numeric   <NA>             3
## 10     4     7 numeric   <NA>             0
## # ... with 16 more rows
```

```
# View the cells in their original positions on the spreadsheet
rectify(all_cells)
```

```
## # A tibble: 5 x 7
##   `row/col` `2(B)`      `3(C)`   `4(D)`  `5(E)` `6(F)`   `7(G)`
```

```
##       <int> <chr>       <chr>    <chr>   <chr>  <chr>    <chr>
## 1         3 <NA>        <NA>     Matilda Olivia Nicholas Paul
## 2         4 Humanities  Classics 1       2      3        0
## 3         5 <NA>        History  3       4      5        1
## 4         6 Performance Music    5       6      9        2
## 5         7 <NA>        Drama    7       8      12       3
```

```
first_header_col <-
  dplyr::filter(all_cells, col == 2) %>%
  select(row, col, field = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the ``character` column.
first_header_col
```

```
## # A tibble: 2 x 3
##     row   col field
##   <int> <int> <chr>
## 1     4     2 Humanities
## 2     6     2 Performance
```

```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
second_header_col
```

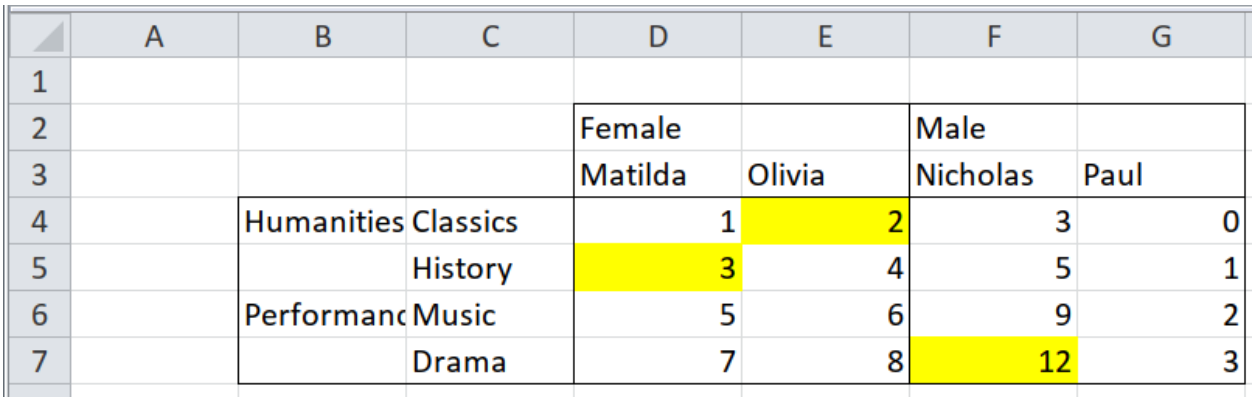
```
## # A tibble: 4 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     4     3 Classics
## 2     5     3 History
## 3     6     3 Music
## 4     7     3 Drama
```

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is examp scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`

data_cells %>%
  enhead(first_header_col, "WNW") %>%
  enhead(second_header_col, "W") %>%
  select(-row, -col)
```

```
## # A tibble: 16 x 3
##    score field       subject
##    <dbl> <chr>       <chr>
##  1     1 Humanities  Classics
##  2     2 Humanities  Classics
##  3     3 Humanities  Classics
```

```
##  4     0 Humanities  Classics
##  5     3 Humanities  History
##  6     4 Humanities  History
##  7     5 Humanities  History
##  8     1 Humanities  History
##  9     5 Performance Music
## 10     6 Performance Music
## 11     9 Performance Music
## 12     2 Performance Music
## 13     7 Performance Drama
## 14     8 Performance Drama
## 15    12 Performance Drama
## 16     3 Performance Drama
```

3.2.3 Two clear rows and columns of text headers, top-aligned and left-aligned



	A	B	C	D	E	F	G
1							
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

This is a combination of the previous two sections. No new techniques are used.

1. Identify which cells are headers, and which are data
2. State how the data cells relate to the header cells.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric) %>%
  print()
```

```
## # A tibble: 28 x 5
##      row   col data_type character  numeric
##    <int> <int> <chr>     <chr>        <dbl>
##  1     2     4 character Female          NA
##  2     2     6 character Male            NA
##  3     3     4 character Matilda         NA
##  4     3     5 character Olivia          NA
##  5     3     6 character Nicholas        NA
##  6     3     7 character Paul            NA
##  7     4     2 character Humanities      NA
##  8     4     3 character Classics        NA
##  9     4     4 numeric   <NA>             1
## 10     4     5 numeric   <NA>             2
```

```
## # ... with 18 more rows
```

```
# View the cells in their original positions on the spreadsheet
rectify(all_cells)
```

```
## # A tibble: 6 x 7
##   `row/col` `2(B)`      `3(C)`   `4(D)`  `5(E)` `6(F)`   `7(G)`
##       <int> <chr>       <chr>    <chr>   <chr>  <chr>    <chr>
## 1         2 <NA>        <NA>     Female  <NA>   Male     <NA>
## 2         3 <NA>        <NA>     Matilda Olivia Nicholas Paul
## 3         4 Humanities  Classics 1       2      3        0
## 4         5 <NA>        History  3       4      5        1
## 5         6 Performance Music    5       6      9        2
## 6         7 <NA>        Drama    7       8      12       3
```

```
first_header_row <-
  dplyr::filter(all_cells, row == 2) %>%
  select(row, col, sex = character)
  # the title of this header is 'sex'
  # the cells are text cells (`"Female"` and `"Male"`) so take the value in the
  # ``character` column.
first_header_row
```

```
## # A tibble: 2 x 3
##     row   col sex
##   <int> <int> <chr>
## 1     2     4 Female
## 2     2     6 Male
```

```
second_header_row <-
  dplyr::filter(all_cells, row == 3) %>%
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the ``character` column.
second_header_row
```

```
## # A tibble: 4 x 3
##     row   col name
##   <int> <int> <chr>
## 1     3     4 Matilda
## 2     3     5 Olivia
## 3     3     6 Nicholas
## 4     3     7 Paul
```

```
first_header_col <-
  dplyr::filter(all_cells, col == 2) %>%
  select(row, col, field = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the ``character` column.
first_header_col
```

```
## # A tibble: 2 x 3
##     row   col field
##   <int> <int> <chr>
## 1     4     2 Humanities
## 2     6     2 Performance
```

```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
second_header_col
```

```
## # A tibble: 4 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     4     3 Classics
## 2     5     3 History
## 3     6     3 Music
## 4     7     3 Drama
```

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is examp scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`

data_cells %>%
  enhead(first_header_row, "NNW") %>%
  enhead(second_header_row, "N") %>%
  enhead(first_header_col, "WNW") %>%
  enhead(second_header_col, "W") %>%
  select(-row, -col)
```

```
## # A tibble: 16 x 5
##    score sex    name     field       subject
##    <dbl> <chr>  <chr>    <chr>       <chr>
##  1     1 Female Matilda  Humanities  Classics
##  2     2 Female Olivia   Humanities  Classics
##  3     3 Female Matilda  Humanities  History
##  4     4 Female Olivia   Humanities  History
##  5     3 Male   Nicholas Humanities  Classics
##  6     0 Male   Paul     Humanities  Classics
##  7     5 Male   Nicholas Humanities  History
##  8     1 Male   Paul     Humanities  History
##  9     5 Female Matilda  Performance Music
## 10     6 Female Olivia   Performance Music
## 11     7 Female Matilda  Performance Drama
## 12     8 Female Olivia   Performance Drama
## 13     9 Male   Nicholas Performance Music
## 14     2 Male   Paul     Performance Music
## 15    12 Male   Nicholas Performance Drama
## 16     3 Male   Paul     Performance Drama
```

3.2.4 Centre-aligned headers

				Female				Male	
			Leah	Matilda	Olivia	Lenny	Max	Nicholas	Paul
		Classics	3	1	2	4	3	3	0
	Humanities	History	8	3	4	7	5	5	1
		Literature	1	1	9	3	12	7	5
		Philosophy	5	10	10	8	2	5	12
		Languages	5	4	5	9	8	3	8
		Music	4	10	10	2	4	5	6
	Performanc	Dance	4	5	6	4	12	9	2
		Drama	2	7	8	6	1	12	3

Headers aren't always aligned to one side of the data cells that they describe.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <- xlsx_cells(path, sheets = "pivot-centre-aligned")
rectify(all_cells)
```

```
## # A tibble: 10 x 10
##    `row/col` `2(B)`    `3(C)`   `4(D)` `5(E)` `6(F)` `7(G)` `8(H)` `9(I)`
##        <int> <chr>     <chr>    <chr>  <chr>  <chr>  <chr>  <chr>  <chr>
##  1         2 <NA>      <NA>     <NA>   Female <NA>   <NA>   <NA>   Male
##  2         3 <NA>      <NA>     Leah   Matil~ Olivia Lenny  Max    Nichol~
##  3         4 <NA>      Classics 3      1      2      4      3      3
##  4         5 Humaniti~ History  8      3      4      7      5      5
##  5         6 <NA>      Literat~ 1      1      9      3      12     7
##  6         7 <NA>      Philoso~ 5      10     10     8      2      5
##  7         8 <NA>      Languag~ 5      4      5      9      8      3
##  8         9 <NA>      Music    4      10     10     2      4      5
##  9        10 Performa~ Dance    4      5      6      4      12     9
## 10        11 <NA>      Drama    2      7      8      6      1      12
## # ... with 1 more variable: `10(J)` <chr>
```

Looking at that table, it's not immediately obvious where the boundary between `Female` and `Male` falls, or between `Humanities` and `Performance`. A naive approach would be to match the inner headers to the outer ones by proximity, and there are four directions to do so: `"ABOVE"`, `"LEFT"`, `"BELOW"`, and `"RIGHT"`.

But in this case, those directions are too naive.

- `Languages` is closest to the `Performance` header, but is a humanity.
- `Lenny` is the same distance from `Female` as from `Male`.

You can fix this by justifying the header cells towards one side of the data cells that they describe, and then use a direction like `"NNW"` as usual. Do this with `justify()`, providing the header cells with a second set of cells at the positions you want the header cells to move to.

- `header_cells` is the cells whose value will be used as the header
- `corner_cells` is the cells whose position is in one corner of the domain of the header (e.g. the top-left-hand corner).

In the original spreadsheet, the borders mark the boundaries. So the corner cells of the headers can be found by filtering for cells with a particular border.

```
all_cells <-
  xlsx_cells(path, sheets = "pivot-centre-aligned") %>%
  select(row, col, is_blank, data_type, character, numeric, local_format_id)

formats <- xlsx_formats(path)
top_borders <- which(!is.na(formats$local$border$top$style))
left_borders <- which(!is.na(formats$local$border$left$style))

first_header_row_corners <-
  dplyr::filter(all_cells, row == 2, local_format_id %in% left_borders) %>%
  select(row, col)
first_header_row_corners
```

```
## # A tibble: 2 x 2
##     row   col
##   <int> <int>
## 1     2     4
## 2     2     7
```

```
first_header_col_corners <-
  dplyr::filter(all_cells, col == 2, local_format_id %in% top_borders) %>%
  select(row, col)
first_header_col_corners
```

```
## # A tibble: 2 x 2
##     row   col
##   <int> <int>
## 1     4     2
## 2     9     2
```

Next, get the first row and first column of header cells as usual.

```
first_header_row <-
  dplyr::filter(all_cells, !is_blank, row == 2) %>%
  select(row, col, sex = character)
  # the title of this header is 'sex'
  # the cells are text cells (`"Female"` and `"Male"`) so take the value in the
  # ``character` column.
first_header_row
```

```
## # A tibble: 2 x 3
##     row   col sex
##   <int> <int> <chr>
## 1     2     5 Female
## 2     2     9 Male
```

```
first_header_col <-
  dplyr::filter(all_cells, !is_blank, col == 2) %>%
  select(row, col, field = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the ``character` column.
first_header_col
```

```
## # A tibble: 2 x 3
##     row   col field
##   <int> <int> <chr>
```

```
## 1     5     2 Humanities
## 2    10     2 Performance
```

And now justify the header cells to the same positions as the corner cells.

```
first_header_row <- justify(first_header_row, first_header_row_corners)
first_header_col <- justify(first_header_col, first_header_col_corners)

first_header_row
```

```
## # A tibble: 2 x 3
##     row   col sex
##   <int> <int> <chr>
## 1     2     4 Female
## 2     2     7 Male
```

```
first_header_col
```

```
## # A tibble: 2 x 3
##     row   col field
##   <int> <int> <chr>
## 1     4     2 Humanities
## 2     9     2 Performance
```

The rest of this example is the same as "Two clear rows and columns of text headers, top-aligned and left-aligned".

```
second_header_row <-
  dplyr::filter(all_cells, row == 3) %>%
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the ``character` column.
second_header_row
```

```
## # A tibble: 7 x 3
##     row   col name
##   <int> <int> <chr>
## 1     3     4 Leah
## 2     3     5 Matilda
## 3     3     6 Olivia
## 4     3     7 Lenny
## 5     3     8 Max
## 6     3     9 Nicholas
## 7     3    10 Paul
```

```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
second_header_col
```

```
## # A tibble: 8 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     4     3 Classics
## 2     5     3 History
```

```
## 3     6     3 Literature
## 4     7     3 Philosophy
## 5     8     3 Languages
## 6     9     3 Music
## 7    10     3 Dance
## 8    11     3 Drama
```

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is examp scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`

data_cells %>%
  enhead(first_header_row, "NNW") %>%
  enhead(second_header_row, "N") %>%
  enhead(first_header_col, "WNW") %>%
  enhead(second_header_col, "W") %>%
  select(-row, -col)
```

```
## # A tibble: 56 x 5
##    score sex    name    field      subject
##    <dbl> <chr>  <chr>   <chr>      <chr>
##  1     3 Female Leah    Humanities Classics
##  2     1 Female Matilda Humanities Classics
##  3     2 Female Olivia  Humanities Classics
##  4     8 Female Leah    Humanities History
##  5     3 Female Matilda Humanities History
##  6     4 Female Olivia  Humanities History
##  7     1 Female Leah    Humanities Literature
##  8     1 Female Matilda Humanities Literature
##  9     9 Female Olivia  Humanities Literature
## 10     5 Female Leah    Humanities Philosophy
## # ... with 46 more rows
```

3.2.5 Multiple rows or columns of headers, with meaningful formatting

	A	B	C	D	E	F	G
1							
2				Female		Male	
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5			History	3	4	5	1
6		Performanc	Music	5	6	9	2
7			Drama	7	8	12	3

This is a combination of the previous section with Meaningfully formatted cells. The section Meaningfully formatted rows doesn't work here, because the unpivoting of multiple rows/columns of headers complicates

the relationship between the data and the formatting.

1. Unpivot the multiple rows/columns of headers, as above, but keep the `row` and `col` of each data cell.
2. Collect the `row`, `col` and formatting of each data cell.
3. Join the data to the formatting by the `row` and `col`.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric) %>%
  print()
```

```
## # A tibble: 28 x 5
##      row   col data_type character  numeric
##    <int> <int> <chr>     <chr>        <dbl>
##  1     2     4 character Female          NA
##  2     2     6 character Male            NA
##  3     3     4 character Matilda         NA
##  4     3     5 character Olivia          NA
##  5     3     6 character Nicholas        NA
##  6     3     7 character Paul            NA
##  7     4     2 character Humanities      NA
##  8     4     3 character Classics        NA
##  9     4     4 numeric   <NA>             1
## 10     4     5 numeric   <NA>             2
## # ... with 18 more rows
```

```
# View the cells in their original positions on the spreadsheet
rectify(all_cells)
```

```
## # A tibble: 6 x 7
##   `row/col` `2(B)`      `3(C)`   `4(D)`  `5(E)` `6(F)`   `7(G)`
##       <int> <chr>       <chr>    <chr>   <chr>  <chr>    <chr>
## 1         2 <NA>        <NA>     Female  <NA>   Male     <NA>
## 2         3 <NA>        <NA>     Matilda Olivia Nicholas Paul
## 3         4 Humanities  Classics 1       2      3        0
## 4         5 <NA>        History  3       4      5        1
## 5         6 Performance Music    5       6      9        2
## 6         7 <NA>        Drama    7       8      12       3
```

```
first_header_row <-
  dplyr::filter(all_cells, row == 2) %>%
  select(row, col, sex = character)
  # the title of this header is 'sex'
  # the cells are text cells (`"Female"` and `"Male"`) so take the value in the
  # ``character` column.
first_header_row
```

```
## # A tibble: 2 x 3
##     row   col sex
##   <int> <int> <chr>
## 1     2     4 Female
## 2     2     6 Male
```

```
second_header_row <-
  dplyr::filter(all_cells, row == 3) %>%
```

```
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the ``character` column.
second_header_row
```

```
## # A tibble: 4 x 3
##     row   col name
##   <int> <int> <chr>
## 1     3     4 Matilda
## 2     3     5 Olivia
## 3     3     6 Nicholas
## 4     3     7 Paul
```

```
first_header_col <-
  dplyr::filter(all_cells, col == 2) %>%
  select(row, col, field = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the ``character` column.
first_header_col
```

```
## # A tibble: 2 x 3
##     row   col field
##   <int> <int> <chr>
## 1     4     2 Humanities
## 2     6     2 Performance
```

```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
second_header_col
```

```
## # A tibble: 4 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     4     3 Classics
## 2     5     3 History
## 3     6     3 Music
## 4     7     3 Drama
```

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is exam scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`

unpivoted <-
  data_cells %>%
  enhead(first_header_row, "NNW") %>%
  enhead(second_header_row, "N") %>%
  enhead(first_header_col, "WNW") %>%
```

```
  enhead(second_header_col, "W")
  # Don't delet the `row` and `col` columns yet, because we need them to join on
  # the formatting

# `formats` is a pallette of fill colours that can be indexed by the
# `local_format_id` of a given cell to get the fill colour of that cell
fill_colours <- xlsx_formats(path)$local$fill$patternFill$fgColor$rgb

# Import all the cells, filter out the header row, filter for the first column,
# and create a new column `approximate` based on the fill colours, by looking up
# the local_format_id of each cell in the `formats` pallette.
annotations <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(row >= 4, col >= 4) %>% # Omit the headers
  mutate(fill_colour = fill_colours[local_format_id]) %>%
  select(row, col, fill_colour)
annotations
```

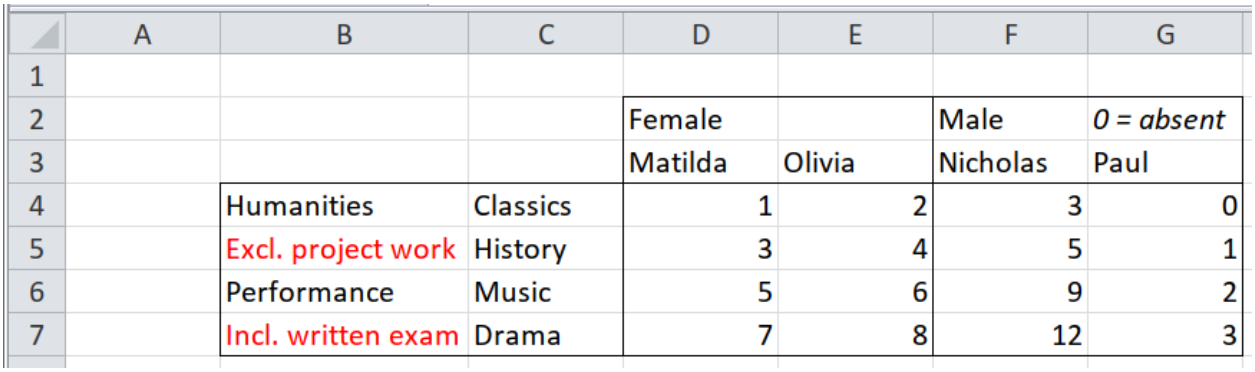
```
## # A tibble: 16 x 3
##      row   col fill_colour
##    <int> <int> <chr>
##  1     4     4 <NA>
##  2     4     5 FFFFFF00
##  3     4     6 <NA>
##  4     4     7 <NA>
##  5     5     4 FFFFFF00
##  6     5     5 <NA>
##  7     5     6 <NA>
##  8     5     7 <NA>
##  9     6     4 <NA>
## 10     6     5 <NA>
## 11     6     6 <NA>
## 12     6     7 <NA>
## 13     7     4 <NA>
## 14     7     5 <NA>
## 15     7     6 FFFFFF00
## 16     7     7 <NA>
```

```
left_join(unpivoted, annotations, by = c("row", "col")) %>%
  select(-row, -col)
```

```
## # A tibble: 16 x 6
##    score sex    name     field       subject  fill_colour
##    <dbl> <chr>  <chr>    <chr>       <chr>    <chr>
##  1     1 Female Matilda  Humanities  Classics <NA>
##  2     2 Female Olivia   Humanities  Classics FFFFFF00
##  3     3 Female Matilda  Humanities  History  FFFFFF00
##  4     4 Female Olivia   Humanities  History  <NA>
##  5     3 Male   Nicholas Humanities  Classics <NA>
##  6     0 Male   Paul     Humanities  Classics <NA>
##  7     5 Male   Nicholas Humanities  History  <NA>
##  8     1 Male   Paul     Humanities  History  <NA>
##  9     5 Female Matilda  Performance Music    <NA>
## 10     6 Female Olivia   Performance Music    <NA>
## 11     7 Female Matilda  Performance Drama    <NA>
```

```
## 12     8 Female Olivia   Performance Drama    <NA>
## 13     9 Male   Nicholas Performance Music    <NA>
## 14     2 Male   Paul     Performance Music    <NA>
## 15    12 Male   Nicholas Performance Drama    FFFFFF00
## 16     3 Male   Paul     Performance Drama    <NA>
```

3.2.6 Mixed headers and notes in the same row/column, distinguished by formatting



	A	B	C	D	E	F	G
1							
2				Female		Male	*0 = absent*
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5		Excl. project work	History	3	4	5	1
6		Performance	Music	5	6	9	2
7		Incl. written exam	Drama	7	8	12	3

This doesn't use any new techniques. The trick is, when selecting a row or column of header cells, to filter out ones that have the 'wrong' formatting (formatting that shows they aren't really headers). In this example, cells with italic or red text aren't headers, even if they are in amongst header cells.

First, identify the IDs of formats that have italic or red text.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
formats <- xlsx_formats(path)

italic <- which(formats$local$font$italic)

# For 'red' we can either look for the RGB code for red "FFFF0000"
red <- which(formats$local$font$color$rgb == "FFFF0000")
red
```

```
## [1] 12 13 14 40 41
```

```
# Or we can find out what that code is by starting from a cell that we know is
# red.
red_cell_format_id <-
  xlsx_cells(path, sheets = "pivot-notes") %>%
  dplyr::filter(row == 5, col == 2) %>%
  pull(local_format_id)
red_cell_format_id
```

```
## [1] 40
```

```
red_rgb <- formats$local$font$color$rgb[red_cell_format_id]
red <- which(formats$local$font$color$rgb == red_rgb)
red
```

```
## [1] 12 13 14 40 41
```

Now we select the headers, filtering out cells with the format IDs of red or italic cells.

```
all_cells <-
  xlsx_cells(path, sheets = "pivot-notes") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, character, numeric, local_format_id) %>%
  print()
```

```
## # A tibble: 31 x 5
##      row   col character  numeric local_format_id
##    <int> <int> <chr>        <dbl>           <int>
##  1     2     4 Female          NA              18
##  2     2     6 Male            NA              18
##  3     2     7 0 = absent      NA              39
##  4     3     4 Matilda         NA              20
##  5     3     5 Olivia          NA              21
##  6     3     6 Nicholas        NA              20
##  7     3     7 Paul            NA              21
##  8     4     2 Humanities      NA              18
##  9     4     3 Classics        NA              19
## 10     4     4 <NA>             1              33
## # ... with 21 more rows
```

```
first_header_row <-
  dplyr::filter(all_cells, row == 2, !(local_format_id %in% c(red, italic))) %>%
  select(row, col, sex = character)
  # the title of this header is 'sex'
  # the cells are text cells (`"Female"` and `"Male"`) so take the value in the
  # ``character` column.
first_header_row
```

```
## # A tibble: 2 x 3
##     row   col sex
##   <int> <int> <chr>
## 1     2     4 Female
## 2     2     6 Male
```

```
first_header_col <-
  dplyr::filter(all_cells, col == 2, !(local_format_id %in% c(red, italic))) %>%
  select(row, col, qualification = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the ``character` column.
first_header_col
```

```
## # A tibble: 2 x 3
##     row   col qualification
##   <int> <int> <chr>
## 1     4     2 Humanities
## 2     6     2 Performance
```

```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
```

```
data_cells %>%
  enhead(first_header_row, "NNW") %>%
  enhead(first_header_col, "WNW") %>%
  select(-row, -col)
```

```
## # A tibble: 16 x 3
##    score sex    qualification
##    <dbl> <chr>  <chr>
##  1     1 Female Humanities
##  2     2 Female Humanities
##  3     3 Female Humanities
##  4     4 Female Humanities
##  5     3 Male   Humanities
##  6     0 Male   Humanities
##  7     5 Male   Humanities
##  8     1 Male   Humanities
##  9     5 Female Performance
## 10     6 Female Performance
## 11     7 Female Performance
## 12     8 Female Performance
## 13     9 Male   Performance
## 14     2 Male   Performance
## 15    12 Male   Performance
## 16     3 Male   Performance
```

3.2.7 Mixed levels of headers in the same row/column, distinguished by formatting

	A	B	C	D
1				
2			Matilda	Nicholas
3		Humanities		
4		Classics	1	3
5		History	3	5
6		Performance		
7		Music	5	9
8		Drama	7	12

Normally different levels of headers are in different rows, or different columns, like Two clear rows of text column headers, left-aligned. But sometimes they coexist in the same row or column, and are distinguishable by formatting, e.g. bold for the top level, italic for the mid level, and plain for the lowest level.

In this example, there is a single column of row headers, where the levels are shown by different amounts of indentation. The indentation is done by formatting, rather than by leading spaces or tabs.

The first step is to find the format IDs of all the different levels of indentation.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
formats <- xlsx_formats(path)

indent0 <- which(formats$local$alignment$indent == 0)
indent1 <- which(formats$local$alignment$indent == 1)

indent0
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
## [24] 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 45 47 48
## [47] 49 50 51 52 53 54 55 56 57 58 59
```

```
indent1
```

```
## [1] 44 46
```

Now we use these format IDs to indentify the different levels of headers in the first column.

```
all_cells <-
  xlsx_cells(path, sheets = "pivot-hierarchy") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric, local_format_id) %>%
  print()
```

```
## # A tibble: 16 x 6
##      row   col data_type character   numeric local_format_id
##    <int> <int> <chr>     <chr>         <dbl>           <int>
##  1     2     3 character Matilda          NA              18
##  2     2     4 character Nicholas         NA              42
##  3     3     2 character Humanities       NA              18
##  4     4     2 character Classics         NA              44
##  5     4     3 numeric   <NA>              1              20
##  6     4     4 numeric   <NA>              3              45
##  7     5     2 character History          NA              44
##  8     5     3 numeric   <NA>              3              20
##  9     5     4 numeric   <NA>              5              45
## 10     6     2 character Performance      NA              20
## 11     7     2 character Music            NA              44
## 12     7     3 numeric   <NA>              5              20
## 13     7     4 numeric   <NA>              9              45
## 14     8     2 character Drama            NA              46
## 15     8     3 numeric   <NA>              7              24
## 16     8     4 numeric   <NA>             12              47
```

```
field <-
  dplyr::filter(all_cells, col == 2, local_format_id %in% indent0) %>%
  select(row, col, field = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the '`character` column.
field
```

```
## # A tibble: 2 x 3
##     row   col field
```

```
##   <int> <int> <chr>
## 1     3     2 Humanities
## 2     6     2 Performance
```

```
subject <-
  dplyr::filter(all_cells, col == 2, local_format_id %in% indent1) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
subject
```

```
## # A tibble: 4 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     4     2 Classics
## 2     5     2 History
## 3     7     2 Music
## 4     8     2 Drama
```

```
name <-
  dplyr::filter(all_cells, row == 2) %>%
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the ``character` column.
name
```

```
## # A tibble: 2 x 3
##     row   col name
##   <int> <int> <chr>
## 1     2     3 Matilda
## 2     2     4 Nicholas
```

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is exam scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`

data_cells %>%
  enhead(field, "WNW") %>%
  enhead(subject, "W") %>%
  enhead(name, "N") %>%
  select(-row, -col)
```

```
## # A tibble: 8 x 4
##   score field       subject  name
##   <dbl> <chr>       <chr>    <chr>
## 1     1 Humanities  Classics Matilda
## 2     3 Humanities  Classics Nicholas
## 3     3 Humanities  History  Matilda
## 4     5 Humanities  History  Nicholas
## 5     5 Performance Music    Matilda
## 6     9 Performance Music    Nicholas
## 7     7 Performance Drama    Matilda
```

```
## 8    12 Performance Drama    Nicholas
```

3.2.8 Repeated rows/columns of headers within the table

	A	B	C	D	E	F
1						
2				Term 1	Term 2	Term 3
3		Classics	Matilda	8	7	5
4			Nicholas	6	9	7
5			Olivia	6	8	9
6			Paul	6	2	3
7				Term 1	Term 2	Term 3
8		History	Matilda	6	4	2
9			Nicholas	3	4	8
10			Olivia	1	7	8
11			Paul	7	9	7
12				Term 1	Term 2	Term 3
13		Music	Matilda	4	2	4
14			Nicholas	7	2	9
15			Olivia	8	5	1
16			Paul	8	2	3
17				Term 1	Term 2	Term 3
18		Drama	Matilda	9	5	1
19			Nicholas	9	0	9
20			Olivia	7	6	4
21			Paul	8	9	4

Repetitions can simply be ignored. Select one of the sets of headers, and use it for all the data. In this example, the data cells are easy to distinguish from the headers mixed in among them, because only the data cells have the `numeric` data type.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-repeated-headers") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric) %>%
  print()
```

```
## # A tibble: 80 x 5
##      row   col data_type character numeric
##    <int> <int> <chr>     <chr>       <dbl>
##  1     2     4 character Term 1         NA
##  2     2     5 character Term 2         NA
##  3     2     6 character Term 3         NA
##  4     3     2 character Classics       NA
##  5     3     3 character Matilda        NA
##  6     3     4 numeric   <NA>            1
##  7     3     5 numeric   <NA>            8
##  8     3     6 numeric   <NA>            7
##  9     4     3 character Nicholas       NA
## 10     4     4 numeric   <NA>            3
## # ... with 70 more rows
```

```
# View the cells in their original positions on the spreadsheet
rectify(all_cells)
```

```
## # A tibble: 20 x 6
##    `row/col` `2(B)`   `3(C)`   `4(D)` `5(E)` `6(F)`
##        <int> <chr>    <chr>    <chr>  <chr>  <chr>
##  1         2 <NA>     <NA>     Term 1 Term 2 Term 3
##  2         3 Classics Matilda  1      8      7
##  3         4 <NA>     Nicholas 3      1      2
##  4         5 <NA>     Olivia   4      0      1
##  5         6 <NA>     Paul     2      4      8
##  6         7 <NA>     <NA>     Term 1 Term 2 Term 3
##  7         8 History  Matilda  4      7      3
##  8         9 <NA>     Nicholas 3      5      5
##  9        10 <NA>     Olivia   9      8      5
## 10        11 <NA>     Paul     6      2      0
## 11        12 <NA>     <NA>     Term 1 Term 2 Term 3
## 12        13 Music    Matilda  2      9      9
## 13        14 <NA>     Nicholas 1      7      7
## 14        15 <NA>     Olivia   0      3      5
## 15        16 <NA>     Paul     2      2      3
## 16        17 <NA>     <NA>     Term 1 Term 2 Term 3
## 17        18 Drama    Matilda  9      8      9
## 18        19 <NA>     Nicholas 1      3      4
## 19        20 <NA>     Olivia   6      1      4
## 20        21 <NA>     Paul     6      0      2
```

```
# The 'term' headers appear four times, but only the first one is needed.
term <-
  dplyr::filter(all_cells, row == 2) %>%
  select(row, col, term = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the ``character` column.
term
```

```
## # A tibble: 3 x 3
##     row   col term
##   <int> <int> <chr>
## 1     2     4 Term 1
## 2     2     5 Term 2
```

```
## 3     2     6 Term 3
```

```
subject <-
  dplyr::filter(all_cells, col == 2) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
subject
```

```
## # A tibble: 4 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     3     2 Classics
## 2     8     2 History
## 3    13     2 Music
## 4    18     2 Drama
```

```
name <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the ``character` column.
name
```

```
## # A tibble: 16 x 3
##      row   col name
##    <int> <int> <chr>
##  1     3     3 Matilda
##  2     4     3 Nicholas
##  3     5     3 Olivia
##  4     6     3 Paul
##  5     8     3 Matilda
##  6     9     3 Nicholas
##  7    10     3 Olivia
##  8    11     3 Paul
##  9    13     3 Matilda
## 10    14     3 Nicholas
## 11    15     3 Olivia
## 12    16     3 Paul
## 13    18     3 Matilda
## 14    19     3 Nicholas
## 15    20     3 Olivia
## 16    21     3 Paul
```

```
# The data cells are distinguished from the 'term' headers by their data type --
# the data cells are numeric, whereas the term headers are character.
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is exam scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`
data_cells
```

```
## # A tibble: 48 x 3
```

```
##      row   col score
##    <int> <int> <dbl>
##  1     3     4     1
##  2     3     5     8
##  3     3     6     7
##  4     4     4     3
##  5     4     5     1
##  6     4     6     2
##  7     5     4     4
##  8     5     5     0
##  9     5     6     1
## 10     6     4     2
## # ... with 38 more rows
```

```
data_cells %>%
  enhead(term, "N") %>%
  enhead(subject, "NNW") %>%
  enhead(name, "W") %>%
  select(-row, -col)
```

```
## # A tibble: 48 x 4
##    score term   subject  name
##    <dbl> <chr>  <chr>    <chr>
##  1     1 Term 1 Classics Matilda
##  2     8 Term 2 Classics Matilda
##  3     7 Term 3 Classics Matilda
##  4     3 Term 1 Classics Nicholas
##  5     1 Term 2 Classics Nicholas
##  6     2 Term 3 Classics Nicholas
##  7     4 Term 1 Classics Olivia
##  8     0 Term 2 Classics Olivia
##  9     1 Term 3 Classics Olivia
## 10     2 Term 1 Classics Paul
## # ... with 38 more rows
```

3.2.9 Headers amongst the data

	A	B	C	D	E
1					
2			**Classics**		
3			Term 1	Term 2	Term 3
4		Matilda	3	5	2
5		Nicholas	5	3	5
6		Olivia	9	6	5
7		Paul	6	3	7
8			**History**		
9			Term 1	Term 2	Term 3
10		Matilda	9	2	2
11		Nicholas	3	4	1
12		Olivia	7	9	3
13		Paul	5	4	8
14			**Music**		
15			Term 1	Term 2	Term 3
16		Matilda	2	2	7
17		Nicholas	7	4	3
18		Olivia	9	9	1
19		Paul	1	8	9
20			**Drama**		
21			Term 1	Term 2	Term 3
22		Matilda	0	5	4
23		Nicholas	8	0	6
24		Olivia	4	0	6
25		Paul	9	7	8

This happens when what is actually a row-header, instead of being presented to the left of the data, is presented above the data. (Alternatively, what is actually a column header, instead of being presented above the data, is presented to the side.)

The way to handle it is to *pretend* that it is a row header, and use the `"WNW"` direction as normal.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-header-within-data") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric, local_format_id) %>%
  print()
```

```
## # A tibble: 80 x 6
##      row   col data_type character numeric local_format_id
##    <int> <int> <chr>     <chr>       <dbl>           <int>
##  1     2     3 character Classics       NA               2
##  2     3     3 character Term 1         NA              20
##  3     3     4 character Term 2         NA              37
##  4     3     5 character Term 3         NA              21
##  5     4     2 character Matilda        NA              18
##  6     4     3 numeric   <NA>            4              18
##  7     4     4 numeric   <NA>            0              27
##  8     4     5 numeric   <NA>            7              19
##  9     5     2 character Nicholas       NA              20
## 10     5     3 numeric   <NA>            4              20
## # ... with 70 more rows
```

```
# View the cells in their original positions on the spreadsheet
rectify(all_cells)
```

```
## # A tibble: 24 x 5
##    `row/col` `2(B)`   `3(C)`   `4(D)` `5(E)`
##        <int> <chr>    <chr>    <chr>  <chr>
##  1         2 <NA>     Classics <NA>   <NA>
##  2         3 <NA>     Term 1   Term 2 Term 3
##  3         4 Matilda  4        0      7
##  4         5 Nicholas 4        6      2
##  5         6 Olivia   9        9      9
##  6         7 Paul     5        0      0
##  7         8 <NA>     History  <NA>   <NA>
##  8         9 <NA>     Term 1   Term 2 Term 3
##  9        10 Matilda  0        4      2
## 10        11 Nicholas 2        5      2
## # ... with 14 more rows
```

```
bold <- which(xlsx_formats(path)$local$font$bold)

# The subject headers, though mixed with the data and the 'term' headers, are
# distinguishable by the data type "character" and by being bold.
subject <-
  dplyr::filter(all_cells,
         col == 3,
         data_type == "character",
         local_format_id %in% bold) %>%
  select(row, col, subject = character)
```

```
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # ``character` column.
subject
```

```
## # A tibble: 4 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     2     3 Classics
## 2     8     3 History
## 3    14     3 Music
## 4    20     3 Drama
```

```
# We only need one set of the 'term' headers
term <-
  dplyr::filter(all_cells, row == 3, data_type == "character") %>%
  select(row, col, term = character)
  # the title of this header is 'field', meaning 'group of subjects'.
  # The cells are text cells (`"Humanities"`, `"Performance"`) so take the value
  # in the ``character` column.
term
```

```
## # A tibble: 3 x 3
##     row   col term
##   <int> <int> <chr>
## 1     3     3 Term 1
## 2     3     4 Term 2
## 3     3     5 Term 3
```

```
name <-
  dplyr::filter(all_cells, col == 2) %>%
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the ``character` column.
name
```

```
## # A tibble: 16 x 3
##      row   col name
##    <int> <int> <chr>
##  1     4     2 Matilda
##  2     5     2 Nicholas
##  3     6     2 Olivia
##  4     7     2 Paul
##  5    10     2 Matilda
##  6    11     2 Nicholas
##  7    12     2 Olivia
##  8    13     2 Paul
##  9    16     2 Matilda
## 10    17     2 Nicholas
## 11    18     2 Olivia
## 12    19     2 Paul
## 13    22     2 Matilda
## 14    23     2 Nicholas
## 15    24     2 Olivia
## 16    25     2 Paul
```

```
# The data cells are distinguished from the 'subject' headers by their data
# type -- the data cells are numeric, whereas the term headers are character.
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is exam scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you would select the `character` and `logical`
  # columns as well as `numeric`
data_cells
```

```
## # A tibble: 48 x 3
##      row   col score
##    <int> <int> <dbl>
##  1     4     3     4
##  2     4     4     0
##  3     4     5     7
##  4     5     3     4
##  5     5     4     6
##  6     5     5     2
##  7     6     3     9
##  8     6     4     9
##  9     6     5     9
## 10     7     3     5
## # ... with 38 more rows
```

```
data_cells %>%
  enhead(subject, "WNW") %>%
  enhead(term, "N") %>%
  enhead(name, "W") %>%
  select(-row, -col)
```

```
## # A tibble: 48 x 4
##    score subject  term   name
##    <dbl> <chr>    <chr>  <chr>
##  1     4 Classics Term 1 Matilda
##  2     0 Classics Term 2 Matilda
##  3     7 Classics Term 3 Matilda
##  4     4 Classics Term 1 Nicholas
##  5     6 Classics Term 2 Nicholas
##  6     2 Classics Term 3 Nicholas
##  7     9 Classics Term 1 Olivia
##  8     9 Classics Term 2 Olivia
##  9     9 Classics Term 3 Olivia
## 10     5 Classics Term 1 Paul
## # ... with 38 more rows
```

Chapter 4

Small multiples

You might have heard the term 'small multiples' in the context of graphs, but it also occurs in spreadsheets, when an array of small tables could be combined into a single table.

To import an array of small tables, start by writing the code to import one, and then apply that to each in turn.

1. Write the code to import one table.
2. Wrap that code in a function.
3. Partition the whole spreadsheet so that each table is in one partition.
4. Map the function over the partitions.

4.1 Small multiples with all headers present for each multiple

	A	B	C	D	E	F	G
1	*Classics*				*History*		
2	**Name**	**Score**	**Grade**		**Name**	**Score**	**Grade**
3	Matilda	1	F		Matilda	3	D
4	Olivia	2	D		Olivia	4	C
5							
6	*Music*				*Drama*		
7	**Name**	**Score**	**Grade**		**Name**	**Score**	**Grade**
8	Matilda	5	B		Matilda	7	A
9	Olivia	6	B		Olivia	8	A

The code to import one of these multiples will be simple.

```
cells %>%
  behead("NNW", subject) %>%
  behead("N", header) %>%
  select(-col, -local_format_id) %>%
  spatter(header) %>%
  select(-row)
```

The first table is in rows 1 to 4, columns 1 to 3, so we start by writing the code to import only that table.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "small-multiples") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric, local_format_id)

table1 <- dplyr::filter(all_cells, row %in% 1:4, col %in% 1:3)

table1 %>%
  behead("NNW", subject) %>%
  behead("N", header) %>%
  select(-col, -local_format_id) %>%
  spatter(header) %>%
  select(-row)
```

```
## # A tibble: 2 x 4
##   subject  Grade Name    Score
##   <chr>    <chr> <chr>   <dbl>
## 1 Classics F     Matilda     1
## 2 Classics D     Olivia      2
```

We wrap that code in a function, to be applied to each separate table.

```
unpivot <- function(cells) {
  cells %>%
    behead("NNW", subject) %>%
    behead("N", header) %>%
    select(-col, -local_format_id) %>%
    spatter(header) %>%
    select(-row)
}
```

Now we partition the spreadsheet into the separate tables. This is done by identifying a corner cell in each table.

```
formats <- xlsx_formats(path)
italic <- which(formats$local$font$italic)

corners <-
  all_cells %>%
  dplyr::filter(local_format_id %in% italic) %>%
  select(row, col)

partitions <- partition(all_cells, corners)
partitions
```

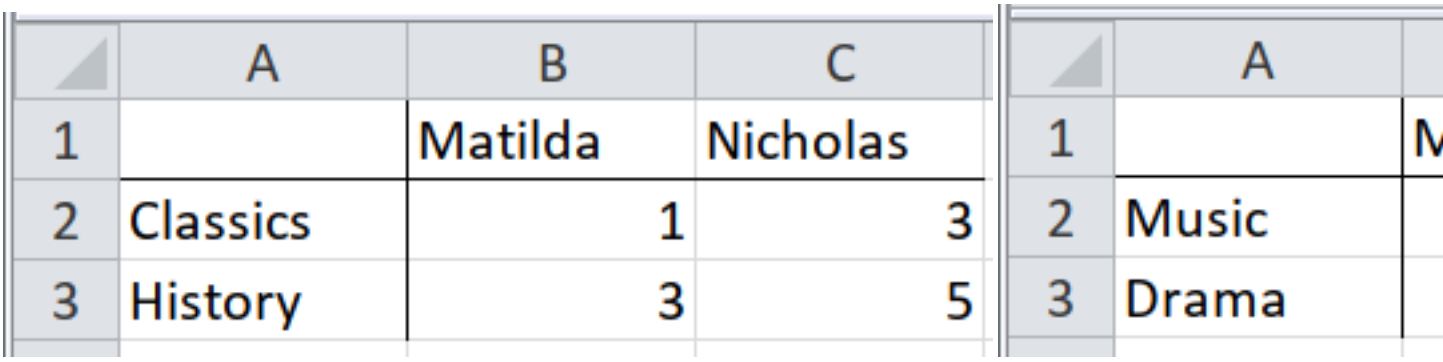
```
## # A tibble: 4 x 3
##   corner_row corner_col cells
##        <dbl>      <dbl> <list>
## 1          1          1 <tibble [10 x 6]>
## 2          1          5 <tibble [10 x 6]>
## 3          6          1 <tibble [10 x 6]>
## 4          6          5 <tibble [10 x 6]>
```

Finally, map the unpivoting function over the partitions, and combine the results.

```
partitions %>%
  mutate(cells = map(cells, unpivot)) %>%
  unnest() %>%
  select(-corner_row, -corner_col)
```

```
## # A tibble: 8 x 4
##   subject  Grade Name    Score
##   <chr>    <chr> <chr>   <dbl>
## 1 Classics F     Matilda     1
## 2 Classics D     Olivia      2
## 3 History  D     Matilda     3
## 4 History  C     Olivia      4
## 5 Music    B     Matilda     5
## 6 Music    B     Olivia      6
## 7 Drama    A     Matilda     7
## 8 Drama    A     Olivia      8
```

4.2 Same table in several worksheets/files (using the sheet/file name)



	A	B	C
1		Matilda	Nicholas
2	Classics	1	3
3	History	3	5

	A
1	
2	Music
3	Drama

Because `tidyxl()` imports cells from multiple sheets into the same data frame, tables on separate sheets can be imported by mapping over the different sheets. Just name each sheet in the `xlsx_cell()` call, or don't name any to import them all.

As far as `tidyxl()` is concerned, the particular sheet (aka 'tab') that a cell is on is another coordinate like `row` and `col`, so the full location of a cell is its `row`, its `col`, and its `sheet`.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = c("humanities", "performance")) %>%
  dplyr::filter(!is_blank) %>%
  select(sheet, row, col, data_type, character, numeric)
all_cells
```

```
## # A tibble: 16 x 6
##    sheet         row   col data_type character numeric
##    <chr>       <int> <int> <chr>     <chr>       <dbl>
##  1 humanities      1     2 character Matilda        NA
##  2 humanities      1     3 character Nicholas       NA
##  3 humanities      2     1 character Classics       NA
##  4 humanities      2     2 numeric   <NA>            1
```

```
##  5 humanities      2     3 numeric   <NA>            3
##  6 humanities      3     1 character History        NA
##  7 humanities      3     2 numeric   <NA>            3
##  8 humanities      3     3 numeric   <NA>            5
##  9 performance     1     2 character Matilda        NA
## 10 performance     1     3 character Nicholas       NA
## 11 performance     2     1 character Music          NA
## 12 performance     2     2 numeric   <NA>            5
## 13 performance     2     3 numeric   <NA>            9
## 14 performance     3     1 character Drama          NA
## 15 performance     3     2 numeric   <NA>            7
## 16 performance     3     3 numeric   <NA>           12
```

To prepare the sheets to be mapped over, use `tidyr::nest()`. The `data` column contains the cells of each sheet.

```
all_cells %>%
  nest(-sheet)
```

```
## # A tibble: 2 x 2
##   sheet       data
##   <chr>       <list>
## 1 humanities  <tibble [8 x 5]>
## 2 performance <tibble [8 x 5]>
```

The function to unpivot each table in this case will be a couple of `behead()` statements. Further clean-up can be saved until the end.

```
unpivot <- function(cells) {
  cells %>%
    behead("N", name) %>%
    behead("W", subject)
}
```

After mapping the unpivot function over each sheet of cells, use `tidyr::unnest()` to show every row of data again.

```
all_cells %>%
  nest(-sheet) %>%
  mutate(data = map(data, unpivot)) %>%
  unnest()
```

```
## # A tibble: 8 x 8
##   sheet         row   col data_type character numeric name     subject
##   <chr>       <int> <int> <chr>     <chr>       <dbl> <chr>    <chr>
## 1 humanities      2     2 numeric   <NA>            1 Matilda  Classics
## 2 humanities      2     3 numeric   <NA>            3 Nicholas Classics
## 3 humanities      3     2 numeric   <NA>            3 Matilda  History
## 4 humanities      3     3 numeric   <NA>            5 Nicholas History
## 5 performance     2     2 numeric   <NA>            5 Matilda  Music
## 6 performance     2     3 numeric   <NA>            9 Nicholas Music
## 7 performance     3     2 numeric   <NA>            7 Matilda  Drama
## 8 performance     3     3 numeric   <NA>           12 Nicholas Drama
```

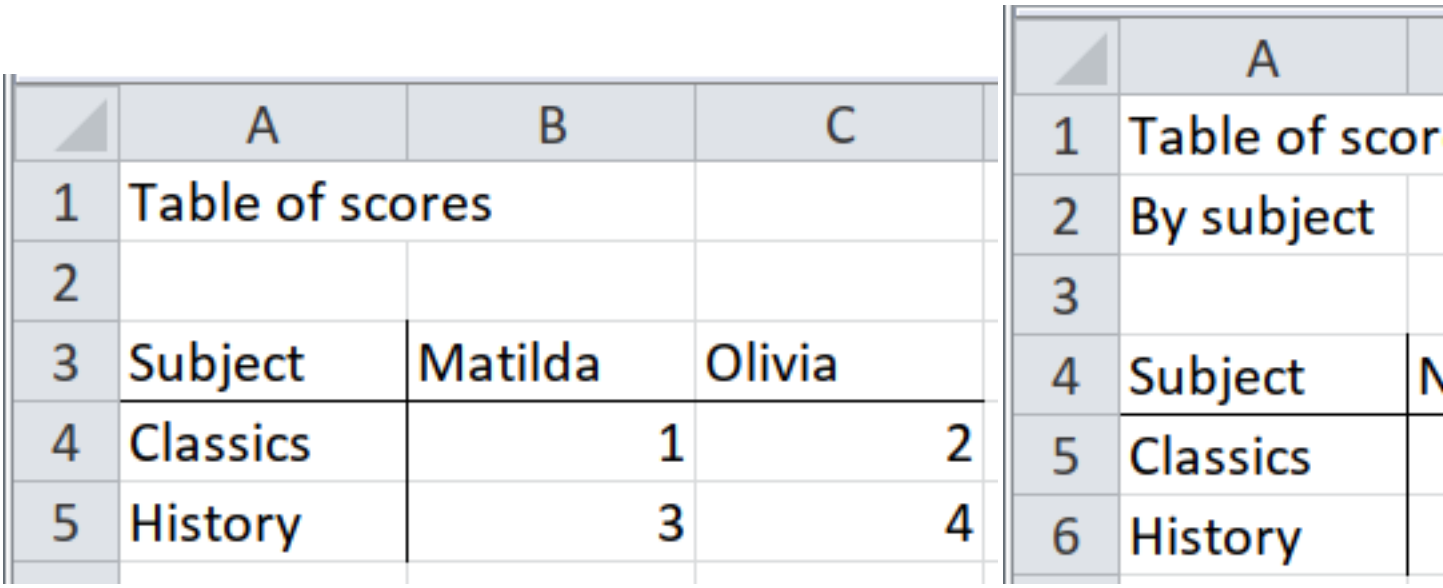
Finally, do the clean-up operations that were saved until now.

```
all_cells %>%
  nest(-sheet) %>%
```

```
  mutate(data = map(data, unpivot)) %>%
  unnest() %>%
  transmute(field = sheet,
            name,
            subject,
            score = numeric)
```

```
## # A tibble: 8 x 4
##   field       name     subject  score
##   <chr>       <chr>    <chr>    <dbl>
## 1 humanities  Matilda  Classics     1
## 2 humanities  Nicholas Classics     3
## 3 humanities  Matilda  History      3
## 4 humanities  Nicholas History      5
## 5 performance Matilda  Music        5
## 6 performance Nicholas Music        9
## 7 performance Matilda  Drama        7
## 8 performance Nicholas Drama       12
```

4.3 Same table in several worksheets/files but in different positions



	A	B	C
1	Table of scores		
2			
3	Subject	Matilda	Olivia
4	Classics	1	2
5	History	3	4

	A
1	Table of scor
2	By subject
3	
4	Subject
5	Classics
6	History

This is almost the same as the section "Same table in several worksheets/files (using the sheet/file name)". The only difference is that the function you write to unpivot the table must also *find* the table in the first place, and be robust to differences in the placement and context of the table on each sheet.

In this example, both tables begin in the same column, but there is an extra row of notes above one of the tables. There are a few ways to tackle this problem. Here, we filter for the `Subject` cell, which is either `A3` or `A4`, and then extend the selection to include the whole table.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = c("female", "male")) %>%
  dplyr::filter(!is_blank) %>%
```

```
  select(sheet, row, col, data_type, character, numeric)
all_cells
```

```
## # A tibble: 21 x 6
##    sheet    row   col data_type character       numeric
##    <chr>  <int> <int> <chr>     <chr>             <dbl>
##  1 female     1     1 character Table of scores      NA
##  2 female     3     1 character Subject              NA
##  3 female     3     2 character Matilda              NA
##  4 female     3     3 character Olivia               NA
##  5 female     4     1 character Classics             NA
##  6 female     4     2 numeric   <NA>                  1
##  7 female     4     3 numeric   <NA>                  2
##  8 female     5     1 character History              NA
##  9 female     5     2 numeric   <NA>                  3
## 10 female     5     3 numeric   <NA>                  4
## # ... with 11 more rows
```

```
unpivot <- function(cells) {
  cells %>%
    dplyr::filter(character == "Subject") %>%
    pull(row) %>%
    {dplyr::filter(cells, row >= .)} %>%
    behead("N", name) %>%
    behead("W", subject)
}

all_cells %>%
  nest(-sheet) %>%
  mutate(data = map(data, unpivot)) %>%
  unnest() %>%
  select(sex = sheet, name, subject, score = numeric)
```

```
## # A tibble: 8 x 4
##   sex    name     subject  score
##   <chr>  <chr>    <chr>    <dbl>
## 1 female Matilda  Classics     1
## 2 female Olivia   Classics     2
## 3 female Matilda  History      3
## 4 female Olivia   History      4
## 5 male   Nicholas Classics     3
## 6 male   Paul     Classics     0
## 7 male   Nicholas History      5
## 8 male   Paul     History      1
```

4.4 Implied multiples

Implied multiples look like a single table, but many of the headers appear more than once. There is a dominant set of headers that are on the same 'level' (e.g. in the same row) as the other headers.

See a real-life case study

	B	C	D	E	F	G	H	I
1	Humanities				Performance			
2	Classics	Grade	History	Grade	Music	Grade	Drama	Grade
3	1	F	3	D	5	B	7	A
4	2	D	4	C	6	B	8	A

In the example, the header "Grade" is repeated, but it really belongs in each case to the header "Classics", "History", "Music" or "Drama". Those subject headers serve two purposes: as title of each small multiple, and as the unstated "Score" header of their columns. The difficulty is in associating a grade with its corresponding score.

1. Filter for the "Classics", "History", "Music" and "Drama" headers, and assign them to a variable to be `enhead()`ed later. You could think of this as faking a set of headers that doesn't exist, but is implied.
2. Meanwhile, `behead()` the original "Classics", "History" (etc.) cells and then overwrite them with "Score".

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "implied-multiples") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric)
```

Filter for the "Classics", "History", "Music" and "Drama" headers, and assign them to a variable to be `enhead()`ed later.

```
subjects <-
  all_cells %>%
  dplyr::filter(col >= 2, row == 2, character != "Grade") %>%
  select(row, col, subject = character)
subjects
```

```
## # A tibble: 4 x 3
##     row   col subject
##   <int> <int> <chr>
## 1     2     2 Classics
## 2     2     4 History
## 3     2     6 Music
## 4     2     8 Drama
```

Meanwhile, `behead()` the original "Classics", "History" (etc.) cells and then overwrite them with "Score".

```
all_cells %>%
  behead("NNW", "field") %>%
  behead("N", "header") %>%
  behead("W", "name") %>%
  enhead(subjects, "NNW") %>% # Reattach the filtered subject headers
  mutate(header = if_else(header == "Grade", header, "Score")) %>%
  select(-col) %>%
  spatter(header) %>%
  select(-row)
```

```
## # A tibble: 8 x 5
##   field       name    subject  Grade Score
##   <chr>       <chr>   <chr>    <chr> <dbl>
## 1 Humanities  Matilda Classics F         1
```

```
## 2 Humanities  Matilda History  D         3
## 3 Performance Matilda Drama    A         7
## 4 Performance Matilda Music    B         5
## 5 Humanities  Olivia  Classics D         2
## 6 Humanities  Olivia  History  C         4
## 7 Performance Olivia  Drama    A         8
## 8 Performance Olivia  Music    B         6
```

Chapter 5

Formatting

This part explains in detail how to extract and interpret cell and in-cell formatting. Earlier sections have used formatting, but haven't explained exactly how it works. The motivating example is a particularly pernicious gotcha: superscript symbols.

The formatting of a cell is available via a lookup table. Well, not a lookup table – a lookup list-of-lists-(of-lists-)of-vectors. It seems complicated, but in fact it is straightforward to find out a cell's formatting.

1. Obtain the vector of formats that you need.
2. Look up the cell's `style_format` or `local_format_id` in that vector.

5.1 An example formatting lookup

This example shows how to look up whether a cell is bold.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
cells <-
  xlsx_cells(path, sheet = "formatting") %>%
  select(row, col, character, style_format, local_format_id)
cells
```

```
## # A tibble: 14 x 5
```

```
##      row   col character          style_format     local_format_id
##    <int> <int> <chr>              <chr>                      <int>
##  1     1     1 bold               Normal                         6
##  2     2     1 italic             Normal                         8
##  3     3     1 underline          Normal                        51
##  4     4     1 strikethrough      Normal                        52
##  5     5     1 red text           Normal                        12
##  6     6     1 font size 14       Normal                        53
##  7     7     1 font arial         Normal                        54
##  8     8     1 yellow fill        Normal                        11
##  9     9     1 black border       Normal                        43
## 10    10     1 thick border       Normal                        55
## 11    11     1 dashed border      Normal                        56
## 12    12     1 row height 30      Normal                         1
## 13    13     2 column width 16.76 Normal                         1
## 14    14     1 Bad' style         Explanatory Text              57
```

```
formats <- xlsx_formats(path)
bold <- formats$local$font$bold # The list of lists of lists of vectors
bold
```

```
##  [1] FALSE  TRUE  TRUE FALSE FALSE  TRUE  TRUE FALSE FALSE FALSE FALSE
## [12] FALSE FALSE FALSE  TRUE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE
## [23] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [34] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [45] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [56] FALSE FALSE FALSE  TRUE
```

```
mutate(cells, bold = bold[local_format_id])
```

```
## # A tibble: 14 x 6
##      row   col character          style_format     local_format_id bold
##    <int> <int> <chr>              <chr>                      <int> <lgl>
##  1     1     1 bold               Normal                         6 TRUE
##  2     2     1 italic             Normal                         8 FALSE
##  3     3     1 underline          Normal                        51 FALSE
##  4     4     1 strikethrough      Normal                        52 FALSE
##  5     5     1 red text           Normal                        12 FALSE
##  6     6     1 font size 14       Normal                        53 FALSE
##  7     7     1 font arial         Normal                        54 FALSE
##  8     8     1 yellow fill        Normal                        11 FALSE
##  9     9     1 black border       Normal                        43 FALSE
## 10    10     1 thick border       Normal                        55 FALSE
## 11    11     1 dashed border      Normal                        56 FALSE
## 12    12     1 row height 30      Normal                         1 FALSE
## 13    13     2 column width 16.76 Normal                         1 FALSE
## 14    14     1 Bad' style         Explanatory Text              57 FALSE
```

A quick way to see what formatting definitions exist is to use `str()`. (Scroll past this for now – you don't need to memorise it).

```
formats <- xlsx_formats(path)
str(formats)
```

```
## List of 2
##  $ local:List of 6
##   ..$ numFmt    : chr [1:59] "General" "General" "General" "General" ...
```

```
##   ..$ font      :List of 10
##   .. ..$ bold     : logi [1:59] FALSE TRUE TRUE FALSE FALSE TRUE ...
##   .. ..$ italic   : logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ underline: chr [1:59] NA NA NA NA ...
##   .. ..$ strike   : logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ vertAlign: chr [1:59] NA NA NA NA ...
##   .. ..$ size     : num [1:59] 11 11 11 11 11 11 11 11 11 11 ...
##   .. ..$ color    :List of 4
##   .. .. ..$ rgb    : chr [1:59] "FF000000" "FF000000" "FF000000" "FF000000" ...
##   .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ name     : chr [1:59] "Calibri" "Calibri" "Calibri" "Calibri" ...
##   .. ..$ family   : int [1:59] 2 2 2 2 2 2 2 2 2 2 ...
##   .. ..$ scheme   : chr [1:59] NA NA NA NA ...
##   ..$ fill      :List of 2
##   .. ..$ patternFill :List of 3
##   .. .. ..$ fgColor    :List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ bgColor    :List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ patternType: chr [1:59] NA NA NA NA ...
##   .. ..$ gradientFill:List of 8
##   .. .. ..$ type  : chr [1:59] NA NA NA NA ...
##   .. .. ..$ degree: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ left  : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ right : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ top   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ bottom: num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ stop1 :List of 2
##   .. .. .. ..$ position: num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ stop2 :List of 2
##   .. .. .. ..$ position: num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   ..$ border    :List of 12
##   .. ..$ diagonalDown: logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ diagonalUp  : logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ outline     : logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ left        :List of 2
```

```
##   .. .. ..$ style: chr [1:59] NA "thin" NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA "FF000000" NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ right       :List of 2
##   .. .. ..$ style: chr [1:59] NA "thin" NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA "FF000000" NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ start       :List of 2
##   .. .. ..$ style: chr [1:59] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ end         :List of 2
##   .. .. ..$ style: chr [1:59] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ top         :List of 2
##   .. .. ..$ style: chr [1:59] NA "thin" NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA "FF000000" NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ bottom      :List of 2
##   .. .. ..$ style: chr [1:59] NA NA "thin" NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA "FF000000" NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ diagonal    :List of 2
##   .. .. ..$ style: chr [1:59] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ vertical    :List of 2
##   .. .. ..$ style: chr [1:59] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
```

```
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ horizontal  :List of 2
##   .. .. ..$ style: chr [1:59] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:59] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:59] NA NA NA NA NA NA NA NA NA NA ...
##   ..$ alignment :List of 8
##   .. ..$ horizontal     : chr [1:59] "general" "center" "general" "general" ...
##   .. ..$ vertical       : chr [1:59] "bottom" "bottom" "bottom" "bottom" ...
##   .. ..$ wrapText       : logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ readingOrder   : chr [1:59] "context" "context" "context" "context" ...
##   .. ..$ indent         : int [1:59] 0 0 0 0 0 0 0 0 0 0 ...
##   .. ..$ justifyLastLine: logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ shrinkToFit    : logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ textRotation   : int [1:59] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ protection:List of 2
##   .. ..$ locked: logi [1:59] TRUE TRUE TRUE TRUE TRUE TRUE ...
##   .. ..$ hidden: logi [1:59] FALSE FALSE FALSE FALSE FALSE FALSE ...
##  $ style:List of 6
##   ..$ numFmt    : Named chr [1:2] "General" "General"
##   .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   ..$ font      :List of 10
##   .. ..$ bold     : Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ italic   : Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ underline: Named chr [1:2] NA NA
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ strike   : Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ vertAlign: Named chr [1:2] NA NA
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ size     : Named num [1:2] 11 11
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ color    :List of 4
##   .. .. ..$ rgb    : Named chr [1:2] "FF000000" "FF9C0006"
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ name     : Named chr [1:2] "Calibri" "Calibri"
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ family   : Named int [1:2] 2 2
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ scheme   : Named chr [1:2] NA NA
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   ..$ fill      :List of 2
##   .. ..$ patternFill :List of 3
##   .. .. ..$ fgColor    :List of 4
```

```
##   .. .. .. ..$ rgb    : Named chr [1:2] NA "FFFFC7CE"
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ bgColor    :List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA "FFCCCCFF"
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ patternType: Named chr [1:2] NA "solid"
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ gradientFill:List of 8
##   .. .. ..$ type  : Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ degree: Named int [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ left  : Named num [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ right : Named num [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ top   : Named num [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ bottom: Named num [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ stop1 :List of 2
##   .. .. .. ..$ position: Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ stop2 :List of 2
##   .. .. .. ..$ position: Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
```

```
##   .. .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   ..$ border    :List of 12
##   .. ..$ diagonalDown: Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ diagonalUp  : Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ outline     : Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ left        :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ right       :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ start       :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ end         :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
```

```
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ top         :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ bottom      :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ diagonal    :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ vertical    :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ horizontal  :List of 2
##   .. .. ..$ style: Named chr [1:2] NA NA
##   .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
```

```
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ theme  : Named chr [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ indexed: Named int [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. .. .. ..$ tint   : Named num [1:2] NA NA
##   .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   ..$ alignment :List of 8
##   .. ..$ horizontal     : Named chr [1:2] "general" "general"
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ vertical       : Named chr [1:2] "bottom" "bottom"
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ wrapText       : Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ readingOrder   : Named chr [1:2] "context" "context"
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ indent         : Named int [1:2] 0 0
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ justifyLastLine: Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ shrinkToFit    : Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ textRotation   : Named int [1:2] 0 0
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   ..$ protection:List of 2
##   .. ..$ locked: Named logi [1:2] TRUE TRUE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
##   .. ..$ hidden: Named logi [1:2] FALSE FALSE
##   .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
```

Why is this so complicated? For one thing, there are too many types of formatting available to include in the data frame given by `xlsx_cells()`.

Consider borders: each cell can have a border on each of its four sides, as well as through the middle of the cell horizontally, vertically, diagonally up and diagonally down. Each border can have its own colour and linetype. Colour can be expressed as an RGB value, a theme number with or without a tint, or an index number.

To express that in a data frame would take (4 sides + 4 through the middle) * (4 ways to express colour + 1 linetype) = 40 columns. Just for borders.

Instead, Excel dynamically defines combinations of formatting, as they occur, and gives ID numbers to those combinations. Each cell has a formatting ID, which is used to look up its particular combination of formats. Note that this means two cells that are both bold can have different formatting IDs, e.g. if one is also italic.

There is also a hierarchy of formatting. The first formatting to be applied is the 'style'. Every cell has a style, which by default is the 'normal' style. You can reformat all cells of the 'normal' style at once by updating the 'normal' style. Style formats are available under `xlsx_formats()$style`

When you modify the format of a particular cell, then that modification is local to that cell. The cell's local formatting is available under `xlsx_formats()$local`. Both `$style` and `$local` have the same structure, so it's easy to switch from checking a cell's style-level formatting to its local formatting.

Here's an example of looking up both the local bold formatting and the style-level bold formatting of a cell.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
cells <-
  xlsx_cells(path, sheet = "formatting") %>%
  select(row, col, character, style_format, local_format_id) %>%
  dplyr::filter(row == 1, col == 1)
cells
```

```
## # A tibble: 1 x 5
##     row   col character style_format local_format_id
##   <int> <int> <chr>     <chr>                 <int>
## 1     1     1 bold      Normal                    6
```

```
formats <- xlsx_formats(path)

local_bold <- formats$local$font$bold
local_bold
```

```
##  [1] FALSE  TRUE  TRUE FALSE FALSE  TRUE  TRUE FALSE FALSE FALSE FALSE
## [12] FALSE FALSE FALSE  TRUE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE
## [23] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [34] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [45] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [56] FALSE FALSE FALSE  TRUE
```

```
style_bold <- formats$style$font$bold
style_bold
```

```
##           Normal Explanatory Text
##            FALSE            FALSE
```

```
mutate(cells,
       style_bold = style_bold[style_format],
       local_bold = local_bold[local_format_id])
```

```
## # A tibble: 1 x 7
##     row   col character style_format local_format_id style_bold local_bold
##   <int> <int> <chr>     <chr>                 <int> <lgl>      <lgl>
## 1     1     1 bold      Normal                    6 FALSE      TRUE
```

Most of the time you will use the local formatting. You only need to check the style formatting when styles have been used in the spreadsheet (rare) and you want to ignore any local modifications of that style for particular cells.

Conditional formatting is an obvious omission. It isn't supported by tidyxl because it doesn't encode any new information; it's responds to cell values, which you already have. If you think you need it, feel free to open an issue.

5.2 Common formats

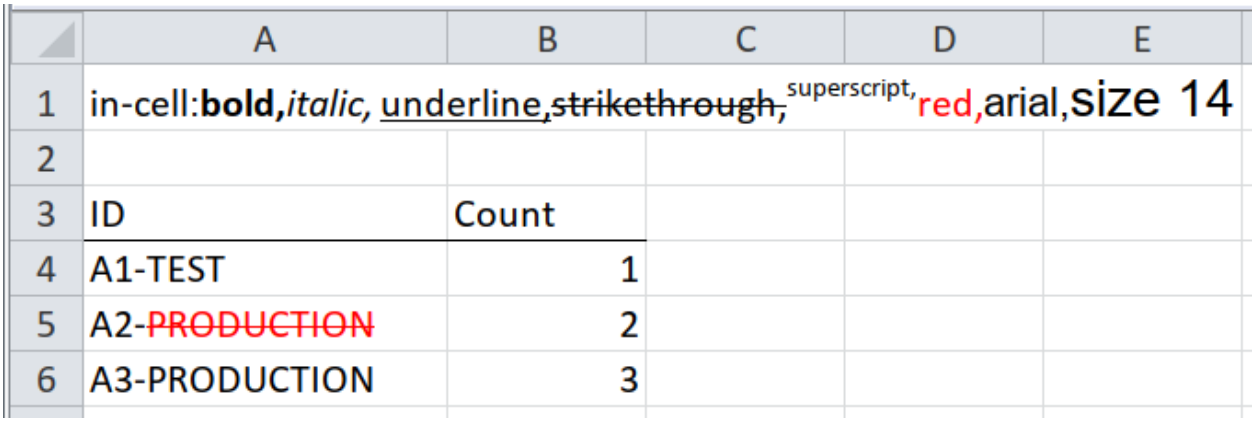
This example shows how to look up the most common formats.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
cells <-
  xlsx_cells(path, sheet = "formatting") %>%
  select(row, col, character, style_format, local_format_id, height, width)

formats <- xlsx_formats(path)
```

```
bold <- formats$local$font$bold
italic <- formats$local$font$italic
underline <- formats$local$font$underline
strikethrough <- formats$local$font$strike
font_colour <- formats$local$font$color$rgb
fill_colour <- formats$local$fill$patternFill$fgColor$rgb
font_size <- formats$local$font$size
font_name <- formats$local$font$name
border_colour <- formats$local$border$right$color$rgb
border_linetype <- formats$local$border$right$style

mutate(cells,
       bold = bold[local_format_id],
       italic = italic[local_format_id],
       underline = underline[local_format_id],
       strikethrough = strikethrough[local_format_id],
       font_colour = font_colour[local_format_id],
       font_size = font_size[local_format_id],
       font_name = font_name[local_format_id],
       fill_colour = fill_colour[local_format_id],
       border_colour = border_colour[local_format_id],
       border_linetype = border_linetype[local_format_id])
```

```
## # A tibble: 14 x 17
##      row   col character   style_format local_format_id height width bold
##    <int> <int> <chr>       <chr>                  <int>  <dbl> <dbl> <lgl>
##  1     1     1 bold        Normal                     6   15    8.71 TRUE
##  2     2     1 italic      Normal                     8   15    8.71 FALSE
##  3     3     1 underline   Normal                    51   15    8.71 FALSE
##  4     4     1 strikethro~ Normal                    52   15    8.71 FALSE
##  5     5     1 red text    Normal                    12   15    8.71 FALSE
##  6     6     1 font size ~ Normal                    53   18.8  8.71 FALSE
##  7     7     1 font arial  Normal                    54   15    8.71 FALSE
##  8     8     1 yellow fill Normal                    11   15    8.71 FALSE
##  9     9     1 black bord~ Normal                    43   15    8.71 FALSE
## 10    10     1 thick bord~ Normal                    55   15    8.71 FALSE
## 11    11     1 dashed bor~ Normal                    56   15    8.71 FALSE
## 12    12     1 row height~ Normal                     1   30    8.71 FALSE
## 13    13     2 column wid~ Normal                     1   15   17.4  FALSE
## 14    14     1 Bad' style  Explanatory~              57   15    8.71 FALSE
## # ... with 9 more variables: italic <lgl>, underline <chr>,
## #   strikethrough <lgl>, font_colour <chr>, font_size <dbl>,
## #   font_name <chr>, fill_colour <chr>, border_colour <chr>,
## #   border_linetype <chr>
```

5.3 In-cell formatting



	A	B	C	D	E
1	in-cell:**bold**,*italic*, underline,~~strikethrough~~,superscript,red,arial,size 14				
2					
3	ID	Count			
4	A1-TEST	1			
5	A2-~~PRODUCTION~~	2			
6	A3-PRODUCTION	3			

The previous section was about formatting applied at the level of cells. What about when multiple formats are applied within a single cell? A single word in a string might be a different colour, to stand out.

Unlike cell-level formatting, in-cell formatting is very limited, so it can be provided as a data frame with the following columns.

- bold
- italic
- underline
- strike
- vertAlign
- size
- color_rgb
- color_theme
- color_indexed
- color_tint
- font
- family
- scheme

There is one of these data frames for each cell, and they are kept in a list-column called `character_formatted`.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
xlsx_cells(path, sheet = "in-cell formatting") %>%
  select(address, character_formatted)
```

```
## # A tibble: 9 x 2
##   address character_formatted
##   <chr>   <list>
## 1 A1      <tibble [9 x 14]>
## 2 A3      <tibble [1 x 14]>
## 3 B3      <tibble [1 x 14]>
## 4 A4      <tibble [1 x 14]>
## 5 B4      <NULL>
## 6 A5      <tibble [2 x 14]>
## 7 B5      <NULL>
## 8 A6      <tibble [1 x 14]>
## 9 B6      <NULL>
```

The way to access these data frames is via `tidyr::unnest()`. In this example, a single cell has a long string of words, where each word is formatted differently.

```
xlsx_cells(path, sheet = "in-cell formatting") %>%
  dplyr::filter(address == "A1") %>%
  select(address, character_formatted) %>%
  unnest()
```

```
## # A tibble: 9 x 15
##   address character      bold  italic underline strike vertAlign    size
##   <chr>   <chr>          <lgl> <lgl>  <chr>     <lgl>  <chr>       <dbl>
## 1 A1      in-cell:       FALSE FALSE  <NA>      FALSE  <NA>            0
## 2 A1      bold,          TRUE  FALSE  <NA>      FALSE  <NA>            0
## 3 A1      italic,        FALSE TRUE   <NA>      FALSE  <NA>            0
## 4 A1      underline,     FALSE FALSE  single    FALSE  <NA>            0
## 5 A1      strikethrough, FALSE FALSE  <NA>      TRUE   <NA>            0
## 6 A1      superscript,   FALSE FALSE  <NA>      FALSE  superscript     0
## 7 A1      red,           FALSE FALSE  <NA>      FALSE  <NA>            0
## 8 A1      arial,         FALSE FALSE  <NA>      FALSE  <NA>            0
## 9 A1      size 14        FALSE FALSE  <NA>      FALSE  <NA>            0
## # ... with 7 more variables: color_rgb <chr>, color_theme <int>,
## #   color_indexed <int>, color_tint <dbl>, font <chr>, family <int>,
## #   scheme <chr>
```

It's hard to think of a plausible example, so what follows is an implausible one that nevertheless occurred in real life.

5.4 Multiple pieces of information in a single cell, with meaningful formatting

	A	B	C	D	E
1	in-cell:**bold,***italic,* underline,~~strikethrough,~~ superscript, red,arial,size 14				
2					
3	ID	Count			
4	A1-TEST	1			
5	A2-~~PRODUCTION~~	2			
6	A3-PRODUCTION	3			

The following table of products and their production readiness combines three pieces of information in a single cell.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
xlsx_cells(path, sheet = "in-cell formatting") %>%
  dplyr::filter(address != "A1") %>%
  rectify()
```

```
## # A tibble: 4 x 3
##   `row/col` `1(A)`        `2(B)`
##       <int> <chr>         <chr>
## 1         3 ID            Count
```

```
## 2         4 A1-TEST       1
## 3         5 A2-PRODUCTION 2
## 4         6 A3-PRODUCTION 3
```

In the `ID` column, the first section `"A1"`, `"A2"`, `"A3"` is the product ID. The second section `"TEST"`, `"PRODUCTION"` is the production readiness, and the formatting of `"TEST"` and `"PRODUCTION"` shows whether or not manufacturing failed. In the file, one of those strings is formatted red with a strikethrough, indicating failure.

One way to extract the formatting is by unnesting, as above, but in this case we can get away with mapping over the nested data frames and pulling out a single value.

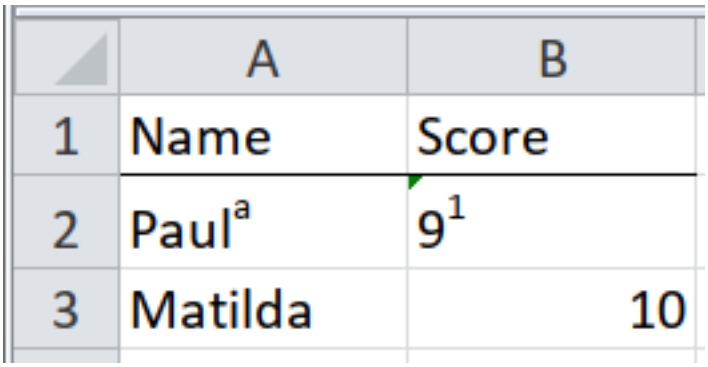
```
strikethrough <-
  xlsx_cells(path, sheet = "in-cell formatting") %>%
  dplyr::filter(address != "A1", col == 1) %>%
  mutate(strikethrough = map_lgl(character_formatted, ~ any(.x$strike))) %>%
  select(row, col, character, strikethrough)
```

This can then be joined onto the rest of the table, in the same way as the section “Already a tidy table but with meaningful formatting of single cells”.

```
cells <-
  xlsx_cells(path, sheet = "in-cell formatting") %>%
  dplyr::filter(address != "A1") %>%
  select(row, col, data_type, character, numeric)

strikethrough <-
  xlsx_cells(path, sheet = "in-cell formatting") %>%
  dplyr::filter(address != "A1", col == 1) %>%
  mutate(strikethrough = map_lgl(character_formatted, ~ any(.x$strike))) %>%
  select(row, strikethrough)

left_join(cells, strikethrough, by = "row") %>%
  behead("N", header) %>%
  select(-col) %>%
  spatter(header) %>%
  select(ID, strikethrough, Count)
```

```
## # A tibble: 3 x 3
##   ID            strikethrough Count
##   <chr>         <lgl>         <dbl>
## 1 A1-TEST       NA                1
## 2 A2-PRODUCTION TRUE              2
## 3 A3-PRODUCTION NA                3
```

5.5 Superscript symbols



	A	B
1	Name	Score
2	Paul[a]	9[1]
3	Matilda	10

This is pernicious. What was Paula's score, in the table below?

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
read_excel(path, sheet = "superscript symbols")
```

```
## # A tibble: 2 x 2
##   Name    Score
##   <chr>   <chr>
## 1 Paula   91
## 2 Matilda 10
```

The answer is, it's not Paula, it's Paul (superscript 'a'), who scored 9 (superscript '1').

This sort of thing is difficult to spot. There's a clue in the 'Score' column, which has been coerced to character so that the author could enter the superscript '1' (Excel doesn't allow superscripts in numeric cells), But it would be easy to interpret that as an accident of translation, and simply coerce back to numeric with `as.integer()`.

With tidyxl, you can count the rows of each element of the `character_formatted` column to identify cells that have in-cell formatting.

```
xlsx_cells(path, sheet = "superscript symbols") %>%
  dplyr::filter(data_type == "character") %>%
  dplyr::filter(map_int(character_formatted, nrow) != 1) %>%
  select(row, col, character)
```

```
## # A tibble: 2 x 3
##     row   col character
##   <int> <int> <chr>
## 1     2     1 Paula
## 2     2     2 91
```

The values and symbols can then be separated by assuming the value is the first string, and the symbol is the second.

```
xlsx_cells(path, sheet = "superscript symbols") %>%
  mutate(character = map_chr(character_formatted,
                             ~ ifelse(is.null(.x), character, .x$character[1])),
         symbol = map_chr(character_formatted,
                          ~ ifelse(is.null(.x), NA, .x$character[2])),
         numeric = if_else(row > 1 & col == 2 & data_type == "character",
                           as.numeric(character),
                           numeric),
```

```
        character = if_else(is.na(numeric), character, NA_character_)) %>%
  select(row, col, numeric, character, symbol)
```

```
## Warning in if_else(row > 1 & col == 2 & data_type == "character",
## as.numeric(character), : NAs introduced by coercion
```

```
## # A tibble: 6 x 5
##     row   col numeric character symbol
##   <int> <int>   <dbl> <chr>     <chr>
## 1     1     1      NA Name      <NA>
## 2     1     2      NA Score     <NA>
## 3     2     1      NA Paul      a
## 4     2     2       9 <NA>      1
## 5     3     1      NA Matilda   <NA>
## 6     3     2      10 <NA>      <NA>
```

Chapter 6

Data validation

TODO: rework the vignette?

Chapter 7

Formulas

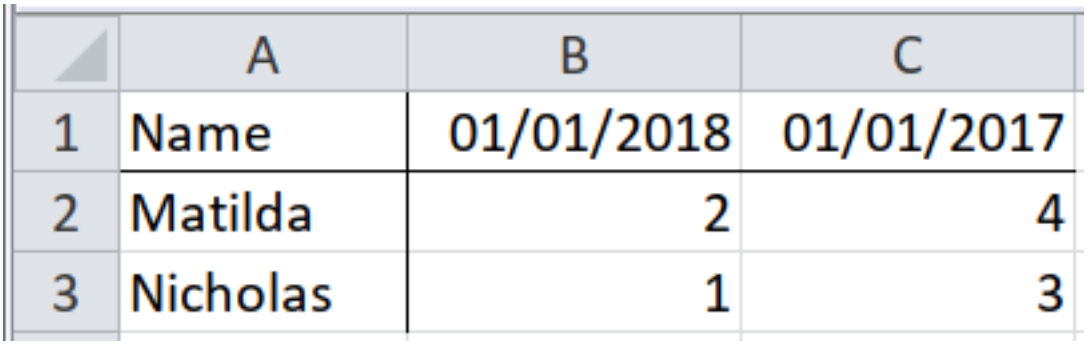
TODO: rework the vignette?

Chapter 8

Other gotchas

This part is a collection of gotchas that don't fit anywhere else.

8.1 Non-text headers e.g. dates



	A	B	C
1	Name	01/01/2018	01/01/2017
2	Matilda	2	4
3	Nicholas	1	3

At the time of writing, readxl doesn't convert Excel dates to R dates when they are in the header row.

Using tidyxl and unpivotr, you can choose to make a cell of any data type into a tidy 'header', and you can reformat it as text before `spatter()` turns it into the header of a data frame. Another way to format headers as part of the `behead()` will be shown later.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
xlsx_cells(path, sheet = "non-text headers") %>%
  behead("W", name) %>%
  behead("N", `academic-year`) %>%
  mutate(`academic-year` = strftime(`academic-year`, "%Y")) %>%
  select(row, data_type, `academic-year`, name, numeric) %>%
  spatter(`academic-year`) %>%
  select(-row)
```

```
## # A tibble: 2 x 3
##   name     `2017` `2018`
##   <chr>     <dbl>  <dbl>
## 1 Matilda       4      2
## 2 Nicholas      3      1
```

When a single set of headers is of mixed data types, e.g. some character and some date, `behead()` chooses the correct ones using the `data_type` column, before converting them all to text via `format()`.

```
xlsx_cells(path, sheet = "non-text headers") %>%
  select(row, col, data_type, character, numeric, date) %>%
  behead("N", header)
```

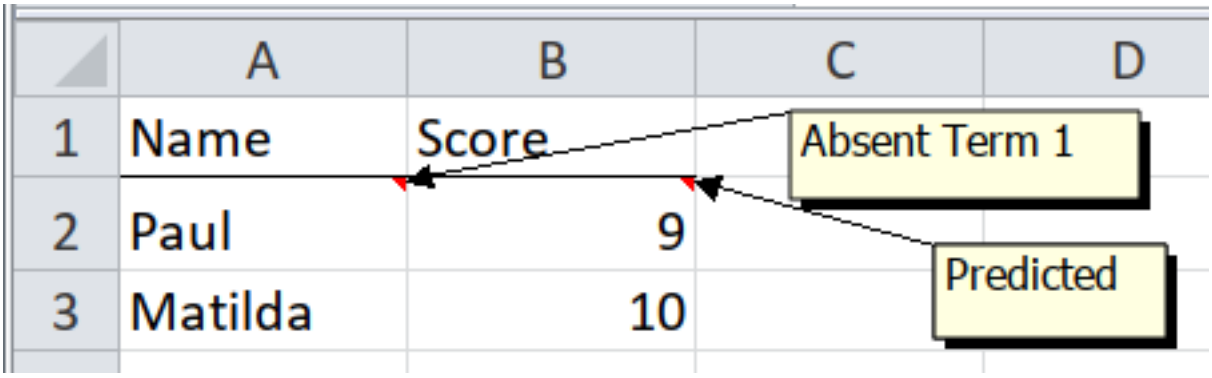
```
## # A tibble: 6 x 7
##     row   col data_type character numeric date                header
##   <int> <int> <chr>     <chr>       <dbl> <dttm>              <chr>
## 1     2     1 character Matilda        NA NA                  Name
## 2     2     2 numeric   <NA>            2 NA                  2018-01-01
## 3     2     3 numeric   <NA>            4 NA                  2017-01-01
## 4     3     1 character Nicholas       NA NA                  Name
## 5     3     2 numeric   <NA>            1 NA                  2018-01-01
## 6     3     3 numeric   <NA>            3 NA                  2017-01-01
```

To format a header when a single set of headers are of mixed data types, you can specify a function for each data type in the call to `behead()`.

```
xlsx_cells(path, sheet = "non-text headers") %>%
  select(row, col, data_type, character, numeric, date) %>%
  behead("N", header, formatters = list(date = ~ strftime(.x, "%Y"),
                                        character = toupper))
```

```
## # A tibble: 6 x 7
##     row   col data_type character numeric date                header
##   <int> <int> <chr>     <chr>       <dbl> <dttm>              <chr>
## 1     2     1 character Matilda        NA NA                  NAME
## 2     2     2 numeric   <NA>            2 NA                  2018
## 3     2     3 numeric   <NA>            4 NA                  2017
## 4     3     1 character Nicholas       NA NA                  NAME
## 5     3     2 numeric   <NA>            1 NA                  2018
## 6     3     3 numeric   <NA>            3 NA                  2017
```

8.2 Data embedded in comments



Comment strings are availabe in the `comment` column, just like `character`. Comments can have formatting, but tidyxl doesn't yet import the formatting. If you need this, please open an issue. It would probably be imported into a `comment_formatted` column, similarly to `character_formatted`.

```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
xlsx_cells(path, sheet = "comments") %>%
  select(row, col, data_type, character, numeric, comment) %>%
  behead("N", "header")
```

```
## # A tibble: 4 x 7
##     row   col data_type character numeric comment       header
##   <int> <int> <chr>     <chr>       <dbl> <chr>         <chr>
## 1     2     1 character Paul           NA Absent Term 1 Name
## 2     2     2 numeric   <NA>            9 Predicted     Score
## 3     3     1 character Matilda        NA <NA>          Name
## 4     3     2 numeric   <NA>           10 <NA>          Score
```

Comments apply to single cells, so follow the same procedure as "Already a tidy table but with meaningful formatting of single cells".

```
cells <-
  xlsx_cells(path, sheet = "comments") %>%
  select(row, col, data_type, character, numeric, comment)
cells
```

```
## # A tibble: 6 x 6
##     row   col data_type character numeric comment
##   <int> <int> <chr>     <chr>       <dbl> <chr>
## 1     1     1 character Name           NA <NA>
## 2     1     2 character Score          NA <NA>
## 3     2     1 character Paul           NA Absent Term 1
## 4     2     2 numeric   <NA>            9 Predicted
## 5     3     1 character Matilda        NA <NA>
## 6     3     2 numeric   <NA>           10 <NA>
```

```
values <-
  cells %>%
  select(-comment) %>%
  behead("N", header) %>%
  select(-col) %>%
  spatter(header)
values
```

```
## # A tibble: 2 x 3
##     row Name    Score
##   <int> <chr>   <dbl>
## 1     2 Paul        9
## 2     3 Matilda    10
```

```
comments <-
  cells %>%
  behead("N", header) %>%
  mutate(header = paste0(header, "_comment")) %>%
  select(row, header, comment) %>%
  spread(header, comment)
comments
```

```
## # A tibble: 2 x 3
##     row Name_comment  Score_comment
##   <int> <chr>         <chr>
## 1     2 Absent Term 1 Predicted
## 2     3 <NA>          <NA>
```

```
left_join(values, comments, by = "row") %>%
  select(-row)
```

```
## # A tibble: 2 x 4
```

```
##   Name    Score Name_comment  Score_comment
##   <chr>   <dbl> <chr>         <chr>
## 1 Paul        9 Absent Term 1 Predicted
## 2 Matilda    10 <NA>          <NA>
```

8.3 Named ranges

TODO

Chapter 9

Case studies

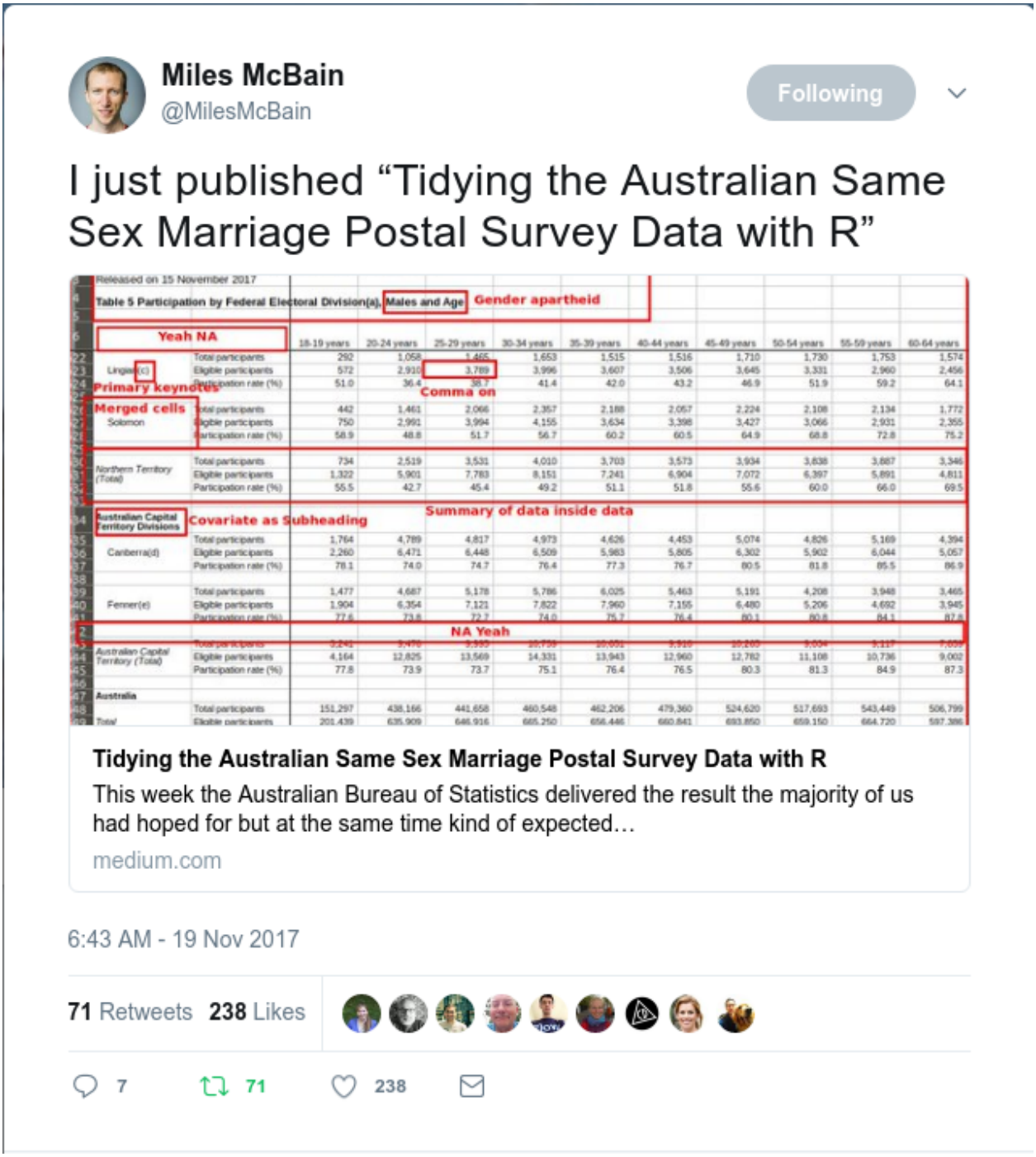
This is a collection of spreadsheets found in the wild. Some are as easy to mung as the examples; others are harder because their structure is less consistent.

Seeing and reading the code will help you guage how much work is still involved in munging a spreadsheet. Attempting them for yourself and checking the model answer will help you to hone your instincts.

The spreadsheet files are provided in the `smungs` package on GitHub. Install as follows.

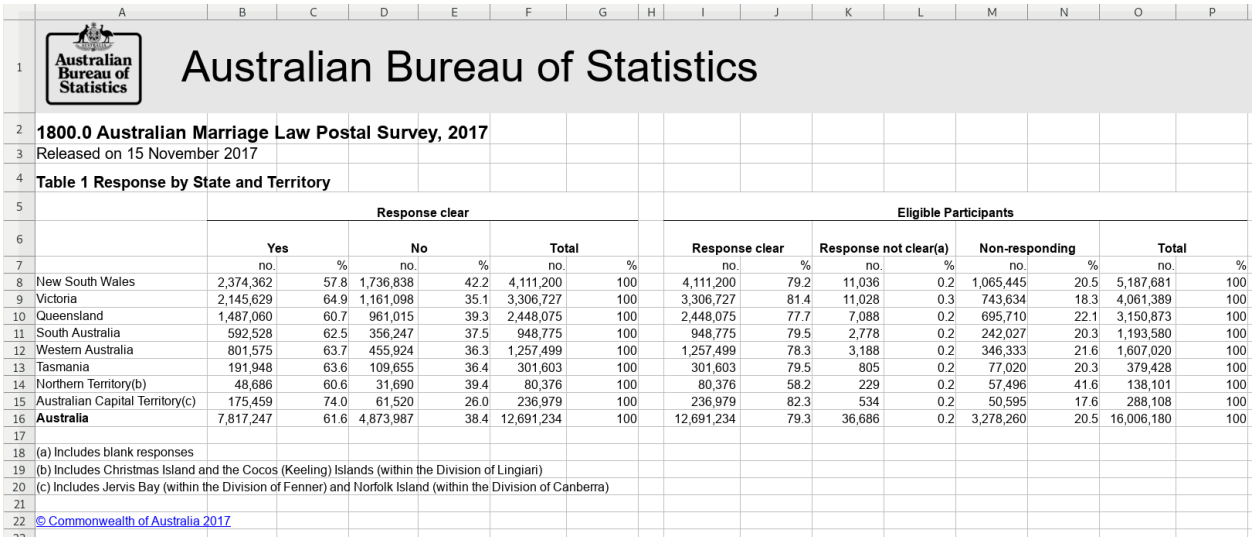
```
# install.packages("devtools") # If you don't already have it
devtools::install_github("nacnudus/smungs")
```

9.1 Australian Marriage Survey



These are the results of a survey in 2017 by the Australian Bureau of Statistics that asked, “Should the law be changed to allow same-sex couples to marry?”

There are two tables with structures that are similar but different. Download the file. Original source.



Australian Bureau of Statistics

1800.0 Australian Marriage Law Postal Survey, 2017

Released on 15 November 2017

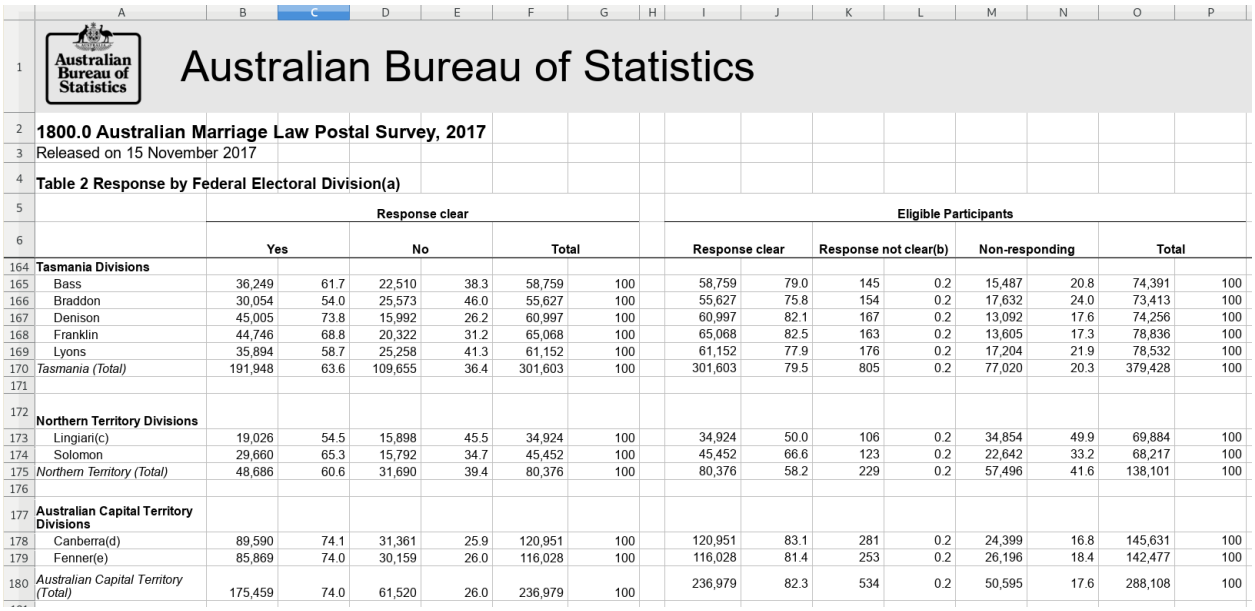
Table 1 Response by State and Territory

	Response clear						Eligible Participants							
	Yes		No		Total		Response clear		Response not clear(a)		Non-responding		Total	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
New South Wales	2,374,362	57.8	1,736,838	42.2	4,111,200	100	4,111,200	79.2	11,036	0.2	1,065,445	20.5	5,187,681	100
Victoria	2,145,629	64.9	1,161,098	35.1	3,306,727	100	3,306,727	81.4	11,028	0.3	743,634	18.3	4,061,389	100
Queensland	1,487,060	60.7	961,015	39.3	2,448,075	100	2,448,075	77.7	7,088	0.2	695,710	22.1	3,150,873	100
South Australia	592,528	62.5	356,247	37.5	948,775	100	948,775	79.5	2,778	0.2	242,027	20.3	1,193,580	100
Western Australia	801,575	63.7	455,924	36.3	1,257,499	100	1,257,499	78.3	3,188	0.2	346,333	21.6	1,607,020	100
Tasmania	191,948	63.6	109,655	36.4	301,603	100	301,603	79.5	805	0.2	77,020	20.3	379,428	100
Northern Territory(b)	48,686	60.6	31,690	39.4	80,376	100	80,376	58.2	229	0.2	57,496	41.6	138,101	100
Australian Capital Territory(c)	175,459	74.0	61,520	26.0	236,979	100	236,979	82.3	534	0.2	50,595	17.6	288,108	100
Australia	7,817,247	61.6	4,873,987	38.4	12,691,234	100	12,691,234	79.3	36,686	0.2	3,278,260	20.5	16,006,180	100

(a) Includes blank responses

(b) Includes Christmas Island and the Cocos (Keeling) Islands (within the Division of Lingiari)

(c) Includes Jervis Bay (within the Division of Fenner) and Norfolk Island (within the Division of Canberra)



Australian Bureau of Statistics

1800.0 Australian Marriage Law Postal Survey, 2017

Released on 15 November 2017

Table 2 Response by Federal Electoral Division(a)

	Response clear						Eligible Participants							
	Yes		No		Total		Response clear		Response not clear(b)		Non-responding		Total	
Tasmania Divisions														
Bass	36,249	61.7	22,510	38.3	58,759	100	58,759	79.0	145	0.2	15,487	20.8	74,391	100
Braddon	30,054	54.0	25,573	46.0	55,627	100	55,627	75.8	154	0.2	17,632	24.0	73,413	100
Denison	45,005	73.8	15,992	26.2	60,997	100	60,997	82.1	167	0.2	13,092	17.6	74,256	100
Franklin	44,746	68.8	20,322	31.2	65,068	100	65,068	82.5	163	0.2	13,605	17.3	78,836	100
Lyons	35,894	58.7	25,258	41.3	61,152	100	61,152	77.9	176	0.2	17,204	21.9	78,532	100
Tasmania (Total)	191,948	63.6	109,655	36.4	301,603	100	301,603	79.5	805	0.2	77,020	20.3	379,428	100
Northern Territory Divisions														
Lingiari(c)	19,026	54.5	15,898	45.5	34,924	100	34,924	50.0	106	0.2	34,854	49.9	69,884	100
Solomon	29,660	65.3	15,792	34.7	45,452	100	45,452	66.6	123	0.2	22,642	33.2	68,217	100
Northern Territory (Total)	48,686	60.6	31,690	39.4	80,376	100	80,376	58.2	229	0.2	57,496	41.6	138,101	100
Australian Capital Territory Divisions														
Canberra(d)	89,590	74.1	31,361	25.9	120,951	100	120,951	83.1	281	0.2	24,399	16.8	145,631	100
Fenner(e)	85,869	74.0	30,159	26.0	116,028	100	116,028	81.4	253	0.2	26,196	18.4	142,477	100
Australian Capital Territory (Total)	175,459	74.0	61,520	26.0	236,979	100	236,979	82.3	534	0.2	50,595	17.6	288,108	100

9.1.1 The full code listing

```
cells <- xlsx_cells(smungs::ozmarriage)
formats <- xlsx_formats(smungs::ozmarriage)

table_1  <-
  cells %>%
  dplyr::filter(sheet == "Table 1", row >= 5L, !is_blank) %>%
  mutate(character = str_trim(character)) %>%
  behead("NNW", "population") %>%
  behead("NNW", "response") %>%
  behead("N", "unit") %>%
  behead("W", "state") %>%
  arrange(row, col) %>%
  select(row, data_type, numeric, state, population, response, unit) %>%
```

```
  spatter(unit) %>%
  select(-row)

state <-
  cells %>%
  dplyr::filter(sheet == "Table 2",
                row >= 5L,
                col == 1L,
                !is_blank,
                formats$local$font$bold[local_format_id]) %>%
  select(row, col, state = character)

table_2 <-
  cells %>%
  dplyr::filter(sheet == "Table 2",
                row >= 5L,
                !is_blank) %>%
  mutate(character = str_trim(character)) %>%
  behead("NNW", "population") %>%
  behead("NNW", "response") %>%
  behead("N", "unit") %>%
  behead("W", "territory") %>%
  enhead(state, "NNW") %>%
  arrange(row, col) %>%
  select(row, data_type, numeric, state, territory, population, response,
         unit) %>%
  spatter(unit) %>%
  select(-row)

all_tables <- bind_rows("Table 1" = table_1, "Table 2" = table_2, .id = "sheet")
all_tables
```

```
## # A tibble: 1,176 x 7
##    sheet   state           population    response     `%`    no. territory
##    <chr>   <chr>           <chr>         <chr>      <dbl>  <dbl> <chr>
##  1 Table 1 New South Wales Eligible Par~ Non-respo~  20.5 1.07e6 <NA>
##  2 Table 1 New South Wales Eligible Par~ Response ~  79.2 4.11e6 <NA>
##  3 Table 1 New South Wales Eligible Par~ Response ~   0.2 1.10e4 <NA>
##  4 Table 1 New South Wales Eligible Par~ Total      100   5.19e6 <NA>
##  5 Table 1 New South Wales Response cle~ No          42.2 1.74e6 <NA>
##  6 Table 1 New South Wales Response cle~ Total      100   4.11e6 <NA>
##  7 Table 1 New South Wales Response cle~ Yes         57.8 2.37e6 <NA>
##  8 Table 1 Victoria        Eligible Par~ Non-respo~  18.3 7.44e5 <NA>
##  9 Table 1 Victoria        Eligible Par~ Response ~  81.4 3.31e6 <NA>
## 10 Table 1 Victoria        Eligible Par~ Response ~   0.3 1.10e4 <NA>
## # ... with 1,166 more rows
```

9.1.2 Step by step

9.1.2.1 Table 1

The first rows, up to the column-headers, must be filtered out. The trailing rows below the table will be treated us row-headers, but because there is no data to join them to, they will be dropped automatically.

That is handy, because otherwise we would have to know where the bottom of the table is, which is likely to change with later editions of the same data.

Apart from filtering the first rows, the rest of this example is 'textbook'.

```
cells <- xlsx_cells(smungs::ozmarriage)

table_1  <-
  cells %>%
  dplyr::filter(sheet == "Table 1", row >= 5L, !is_blank) %>%
  mutate(character = str_trim(character)) %>%
  behead("NNW", "population") %>%
  behead("NNW", "response") %>%
  behead("N", "unit") %>%
  behead("W", "state") %>%
  arrange(row, col) %>%
  select(row, data_type, numeric, state, population, response, unit) %>%
  spatter(unit) %>%
  select(-row)

table_1
```

```
## # A tibble: 63 x 5
##    state           population            response               `%`    no.
##    <chr>           <chr>                 <chr>                <dbl>  <dbl>
##  1 New South Wales Eligible Participants Non-responding        20.5 1.07e6
##  2 New South Wales Eligible Participants Response clear        79.2 4.11e6
##  3 New South Wales Eligible Participants Response not clear(~   0.2 1.10e4
##  4 New South Wales Eligible Participants Total                100   5.19e6
##  5 New South Wales Response clear        No                    42.2 1.74e6
##  6 New South Wales Response clear        Total                100   4.11e6
##  7 New South Wales Response clear        Yes                   57.8 2.37e6
##  8 Victoria        Eligible Participants Non-responding        18.3 7.44e5
##  9 Victoria        Eligible Participants Response clear        81.4 3.31e6
## 10 Victoria        Eligible Participants Response not clear(~   0.3 1.10e4
## # ... with 53 more rows
```

9.1.2.2 Table 2

This is like Table 1, broken down by division rather than by state. The snag is that the states are named in the same column as their divisions. Because the state names are formatted in bold, we can isolate them from the division names. With them out of the way, unpivot the rest of the table as normal, and then use `enhead()` at the end to join the state names back on.

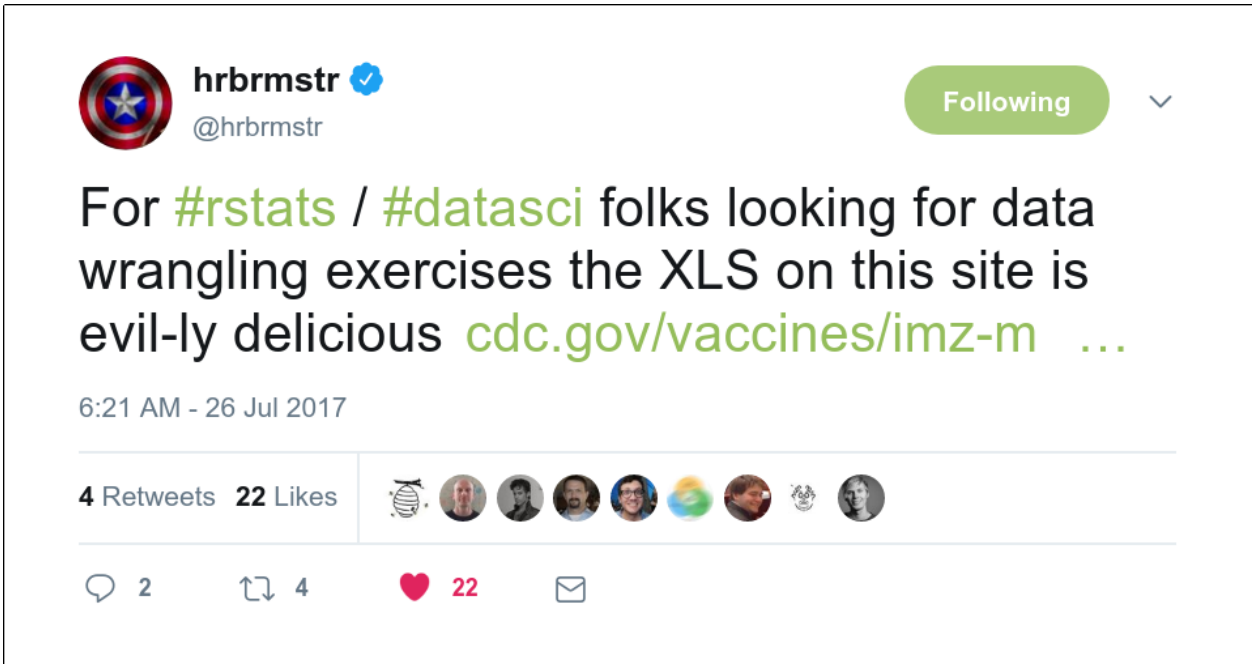
Since tables 1 and 2 are so similar structurally, they might as well be joined into one.

```
cells <- xlsx_cells(smungs::ozmarriage)
formats <- xlsx_formats(smungs::ozmarriage)

state <-
  cells %>%
  dplyr::filter(sheet == "Table 2",
                row >= 5L,
                col == 1L,
                !is_blank,
```

```
                formats$local$font$bold[local_format_id]) %>%
  select(row, col, state = character)

table_2 <-
  cells %>%
  dplyr::filter(sheet == "Table 2",
                row >= 5L,
                !is_blank) %>%
  mutate(character = str_trim(character)) %>%
  behead("NNW", "population") %>%
  behead("NNW", "response") %>%
  behead("N", "unit") %>%
  behead("W", "territory") %>%
  enhead(state, "NNW") %>%
  arrange(row, col) %>%
  select(row, data_type, numeric, state, territory, population, response,
         unit) %>%
  spatter(unit) %>%
  select(-row)

all_tables <-
  bind_rows("Table 1" = table_1, "Table 2" = table_2, .id = "sheet") %>%
  select(sheet, state, territory, population, response, `%`, no.)
all_tables
```

```
## # A tibble: 1,176 x 7
##    sheet   state           territory population    response     `%`    no.
##    <chr>   <chr>           <chr>     <chr>         <chr>      <dbl>  <dbl>
##  1 Table 1 New South Wales <NA>      Eligible Par~ Non-respo~  20.5 1.07e6
##  2 Table 1 New South Wales <NA>      Eligible Par~ Response ~  79.2 4.11e6
##  3 Table 1 New South Wales <NA>      Eligible Par~ Response ~   0.2 1.10e4
##  4 Table 1 New South Wales <NA>      Eligible Par~ Total      100   5.19e6
##  5 Table 1 New South Wales <NA>      Response cle~ No          42.2 1.74e6
##  6 Table 1 New South Wales <NA>      Response cle~ Total      100   4.11e6
##  7 Table 1 New South Wales <NA>      Response cle~ Yes         57.8 2.37e6
##  8 Table 1 Victoria        <NA>      Eligible Par~ Non-respo~  18.3 7.44e5
##  9 Table 1 Victoria        <NA>      Eligible Par~ Response ~  81.4 3.31e6
## 10 Table 1 Victoria        <NA>      Eligible Par~ Response ~   0.3 1.10e4
## # ... with 1,166 more rows
```

9.2 Vaccinations



This is a real-life example of implied multiples. Implied multiples look like a single table, but many of the headers appear more than once. There is a dominant set of headers that are on the same 'level' (e.g. in the same row) as the other headers.

In this case, there is a small multiple for each year of data. The year headers are highlighted in yellow in the screenshot.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1																			
2																			
3	Names	2009-10	OOTNOTE	RVEY TY	GARTEN	ENT SURV	TARGET	2010-11	OOTNOTE	RVEY TY	GARTEN	ENT SURV	TARGET	2011-12	OOTNOTE	RVEY TY	GARTEN	ENT SURV	TARGET
4	Alabama	94.0	≥. *. **	Census	75358	100.0	95.0	NA	NA	NA	NA	NA	95.0	93.6	≥. * .**	Census	73190	100.0	95.0
5	Alaska	NA	NaN	Voluntary	9641	76.4	95.0	NA	NA	NA	NA	NA	95.0	NA	NaN	Non-rando	10286	7.3	95.0
6	Arizona	95.0	NaN	Census	89287	93.9	95.0	NA	NA	NA	NA	NA	95.0	94.7	NaN	Census	88293	96.9	95.0
7	Arkansas	98.3	*	Census	34733	100.0	95.0	NA	NA	NA	NA	NA	95.0	94.9	NaN	Census	38754	92.2	95.0
8	California	93.6	*	Census	507191	100.0	95.0	NA	NA	NA	NA	NA	95.0	93.2	NaN	Census	542544	97.6	95.0
9	Colorado	NA	NaN	Not condu	NA	NA	95.0	NA	NA	NA	NA	NA	95.0	86.8	NaN	Simple Ra	70142	0.5	95.0
10	Connectic	98.5	*	Census	46158	100.0	95.0	NA	NA	NA	NA	NA	95.0	97.4	*	Census	45695	100.0	95.0
11	Delaware	89.7	NaN	Random s	11327	9.2	95.0	NA	NA	NA	NA	NA	95.0	96.9	≥	2-stage Cl	11327	7.4	95.0

The way to unpivot this is to realise that the year cells represent two different things: the year (obviously) and a statistic (percentage vaccinated). It would have been easier to unpivot if the years had been put into a separate row of headers, so we will pretend that that was in fact the case.

1. Filter for the year cells and store in a variable to `enhead()` later.
2. `behead()` everything else as usual, and then overwite the year headers with `percentage_vaccinated`.
3. `enhead()` the year cells.

The original spreadsheet has been replaced by an annual refresh, so you will need to use the file from the smungs package.

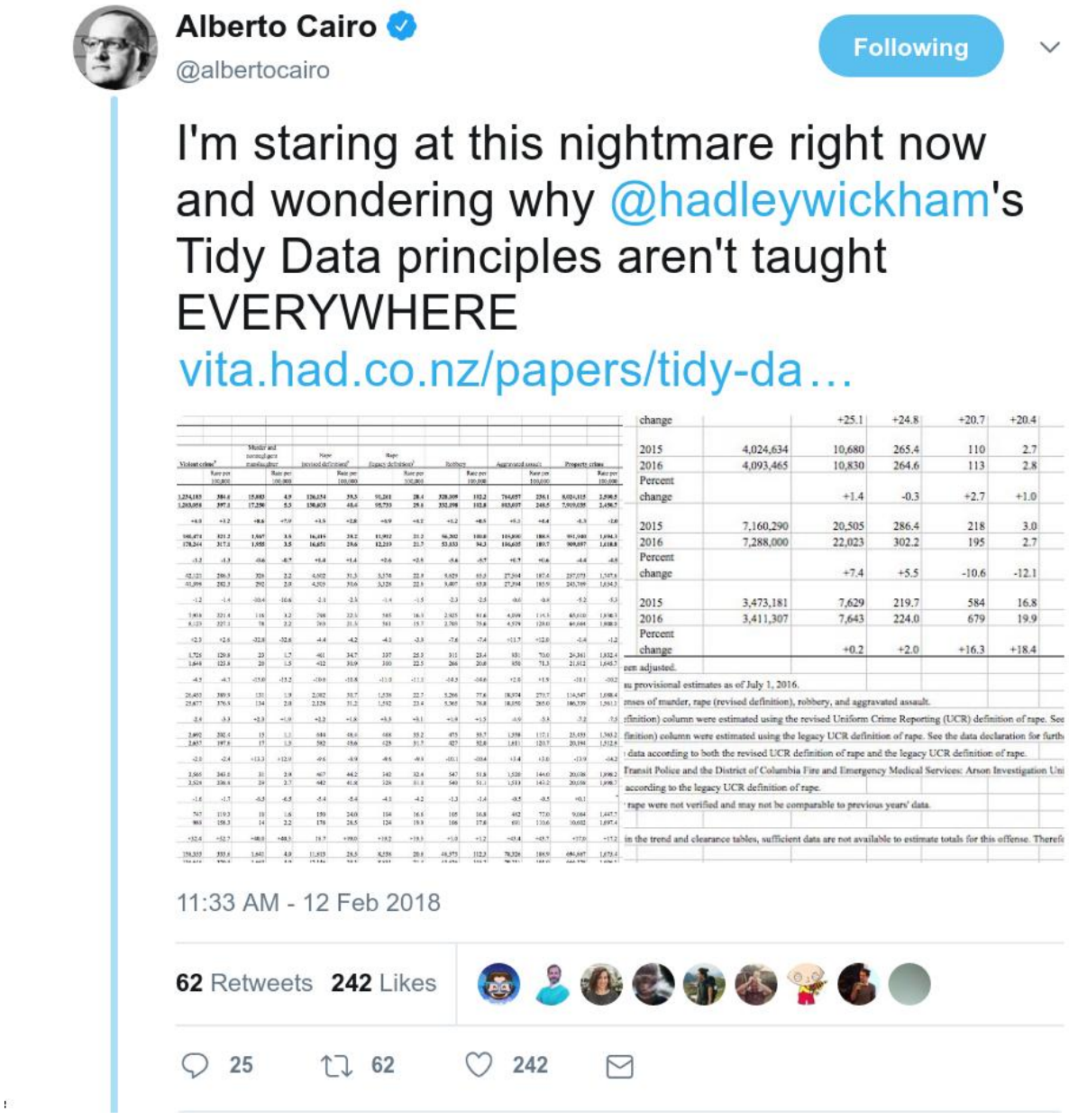
```
cells <- xlsx_cells(smungs::vaccinations, "SVV Coverage Trend Data")

years <-
  cells %>%
  dplyr::filter(row == 3,
                col >= 1,
                str_detect(character, "20[0-9]{2}-[0-9]{2}")) %>%
  select(row, col, year = character)
years
```

```
## # A tibble: 42 x 3
##      row   col year
##    <int> <int> <chr>
##  1     3     2 2009-10
##  2     3     8 2010-11
##  3     3    14 2011-12
##  4     3    20 2012-13
##  5     3    26 2013-14
##  6     3    32 2014-15
##  7     3    38 2015-16
##  8     3    44 2009-10
##  9     3    50 2010-11
## 10     3    56 2011-12
## # ... with 32 more rows
```

```
cells %>%
  select(row, col, data_type, character) %>%
  behead("NNW", "series") %>%
  behead("NNW", "population") %>%
  behead("W", "state") %>%
  behead("N", "header") %>%
  mutate(header = if_else(str_detect(header, "20[0-9]{2}-[0-9]{2}"),
                          "percent_vaccinated",
                          header),
         header = str_replace_all(str_to_lower(header), " ", "_")) %>%
  enhead(years, "NNW") %>%
  select(row, series, population, state, year, header, character) %>%
  spatter(header, character) %>%
  select(series, population, state, year, percent_vaccinated, percent_surveyed,
         everything())
```

```
## # A tibble: 2,226 x 11
##    series   population state year  percent_vaccina~ percent_surveyed   row
##    <chr>    <chr>      <chr> <chr> <chr>            <chr>            <int>
##  1 School ~ All kinde~ Alab~ 2009~ 94.0             100.0                4
##  2 School ~ All kinde~ Alab~ 2010~ NA               NA                   4
##  3 School ~ All kinde~ Alab~ 2011~ 93.6             100.0                4
##  4 School ~ All kinde~ Alab~ 2012~ 92.8             100.0                4
##  5 School ~ All kinde~ Alab~ 2013~ 92.0             100.0                4
##  6 School ~ All kinde~ Alab~ 2014~ 93.5             100.0                4
##  7 School ~ All kinde~ Alab~ 2015~ 93.1             100.0                4
##  8 School ~ All kinde~ Alab~ 2009~ NReq             100.0                4
##  9 School ~ All kinde~ Alab~ 2010~ NA               NA                   4
## 10 School ~ All kinde~ Alab~ 2011~ NReq             100.0                4
## # ... with 2,216 more rows, and 4 more variables: footnotes <chr>,
## #   survey_type <chr>, target <chr>, total_kindergarten_population <chr>
```

9.3 US Crime



These are two tables of numbers of crimes in the USA, by state and category of crime. Confusingly, they're numbered Table 2 and Table 3. Table 1 exists but isn't included in this case study because it is so straightforward.

9.3.1 Table 2

Table 2

Crime in the United States[3]
by Region, Geographic Division, and State, 2015–2016

Area	Year	Population[2]	Violent crime[3]	Rate per 100,000	Murder and nonnegligent manslaughter	Rate per 100,000	Rape (revised definition)[4]	Rate per 100,000	Rape (legacy definition)[5]	Rate per 100,000	Robbery	Rate per 100,000	Aggravated assault	Rate per 100,000	Property crime	Rate per 100,000	Burglary	Rate per 100,000	Larceny-theft	Rate per 100,000	Motor vehicle theft	Rate per 100,000
United States Total[6,7,8,9]	**2015**	**320,896,618**	**1,234,183**	**384.6**	**15,883**	**4.9**	**126,134**	**39.3**	**91,261**	**28.4**	**328,109**	**102.2**	**764,057**	**238.1**	**8,024,115**	**2,500.5**	**1,587,564**	**494.7**	**5,723,488**	**1,783.6**	**713,063**	**222.2**
	2016	**323,127,513**	**1,283,058**	**397.1**	**17,250**	**5.3**	**130,603**	**40.4**	**95,730**	**29.6**	**332,198**	**102.8**	**803,007**	**248.5**	**7,919,035**	**2,450.7**	**1,515,096**	**468.9**	**5,638,455**	**1,745.0**	**765,484**	**236.9**
	Percent change		**+4.0**	**+3.2**	**+8.6**	**+7.9**	**+3.5**	**+2.8**	**+4.9**	**+4.2**	**+1.2**	**+0.5**	**+5.1**	**+4.4**	**-1.3**	**-2.0**	**-4.6**	**-5.2**	**-1.5**	**-2.2**	**+7.4**	**+6.6**
Northeast[6]	**2015**	**56,184,737**	**180,474**	**321.2**	**1,967**	**3.5**	**16,415**	**29.2**	**11,912**	**21.2**	**56,202**	**100.0**	**105,890**	**188.5**	**951,940**	**1,694.3**	**157,910**	**281.1**	**737,087**	**1,311.9**	**56,943**	**101.3**
	2016	**56,209,510**	**178,244**	**317.1**	**1,955**	**3.5**	**16,651**	**29.6**	**12,219**	**21.7**	**53,033**	**94.3**	**106,605**	**189.7**	**909,897**	**1,618.8**	**142,720**	**253.9**	**709,721**	**1,262.6**	**57,456**	**102.2**
	Percent change		**-1.2**	**-1.3**	**-0.6**	**-0.7**	**+1.4**	**+1.4**	**+2.6**	**+2.5**	**-5.6**	**-5.7**	**+0.7**	**+0.6**	**-4.4**	**-4.5**	**-9.6**	**-9.7**	**-3.7**	**-3.8**	**+0.9**	**+0.9**
New England[6]	2015	14,710,229	42,121	286.3	326	2.2	4,602	31.3	3,374	22.9	9,629	65.5	27,564	187.4	257,073	1,747.6	46,260	314.5	193,051	1,312.4	17,762	120.7
	2016	14,735,525	41,598	282.3	292	2.0	4,505	30.6	3,328	22.6	9,407	63.8	27,394	185.9	243,769	1,654.3	42,095	285.7	182,985	1,241.8	18,689	126.8
	Percent change		-1.2	-1.4	-10.4	-10.6	-2.1	-2.3	-1.4	-1.5	-2.3	-2.5	-0.6	-0.8	-5.2	-5.3	-9.0	-9.2	-5.2	-5.4	+5.2	+5.0
Connecticut	2015	3,584,730	7,938	221.4	116	3.2	798	22.3	585	16.3	2,925	81.6	4,099	114.3	65,610	1,830.3	10,286	286.9	48,898	1,364.1	6,426	179.3
	2016	3,576,452	8,123	227.1	78	2.2	763	21.3	561	15.7	2,703	75.6	4,579	128.0	64,664	1,808.0	10,045	280.9	47,512	1,328.5	7,107	198.7
	Percent change		+2.3	+2.6	-32.8	-32.6	-4.4	-4.2	-4.1	-3.9	-7.6	-7.4	+11.7	+12.0	-1.4	-1.2	-2.3	-2.1	-2.8	-2.6	+10.6	+10.9
Maine	2015	1,329,453	1,726	129.8	23	1.7	461	34.7	337	25.3	311	23.4	931	70.0	24,361	1,832.4	4,694	353.1	18,853	1,418.1	814	61.2
	2016	1,331,479	1,648	123.8	20	1.5	412	30.9	300	22.5	266	20.0	950	71.3	21,912	1,645.7	4,003	300.6	17,134	1,286.8	775	58.2
	Percent change		-4.5	-4.7	-13.0	-13.2	-10.6	-10.8	-11.0	-11.1	-14.5	-14.6	+2.0	+1.9	-10.1	-10.2	-14.7	-14.9	-9.1	-9.3	-4.8	-4.9
Massachusetts	2015	6,784,240	26,453	389.9	131	1.9	2,082	30.7	1,538	22.7	5,266	77.6	18,974	279.7	114,547	1,688.4	21,826	321.7	84,676	1,248.1	8,045	118.6
	2016	6,811,779	25,677	376.9	134	2.0	2,128	31.2	1,592	23.4	5,365	78.8	18,050	265.0	106,339	1,561.1	19,193	281.8	79,088	1,161.0	8,058	118.3
	Percent change		-2.9	-3.3	+2.3	+1.9	+2.2	+1.8	+3.5	+3.1	+1.9	+1.5	-4.9	-5.3	-7.2	-7.5	-12.1	-12.4	-6.6	-7.0	+0.2	-0.2
New Hampshire	2015	1,330,111	2,692	202.4	15	1.1	644	48.4	468	35.2	475	35.7	1,558	117.1	23,453	1,763.2	3,482	261.8	19,076	1,434.2	895	67.3
	2016	1,334,795	2,637	197.6	17	1.3	582	43.6	423	31.7	427	32.0	1,611	120.7	20,194	1,512.9	2,963	222.0	16,360	1,225.7	871	65.3
	Percent change		-2.0	-2.4	+13.3	+12.9	-9.6	-9.9	-9.6	-9.9	-10.1	-10.4	+3.4	+3.0	-13.9	-14.2	-14.9	-15.2	-14.2	-14.5	-2.7	-3.0
Rhode Island[6]	2015	1,055,607	2,565	243.0	31	2.9	467	44.2	342	32.4	547	51.8	1,520	144.0	20,038	1,898.2	3,938	373.1	14,714	1,393.9	1,386	131.3
	2016	1,056,426	2,524	238.9	29	2.7	442	41.8	328	31.0	540	51.1	1,513	143.2	20,058	1,898.7	3,788	358.6	14,674	1,389.0	1,596	151.1
	Percent change		-1.6	-1.7	-6.5	-6.5	-5.4	-5.4	-4.1	-4.2	-1.3	-1.4	-0.5	-0.5	+0.1	*	-3.8	-3.9	-0.3	-0.3	+15.2	+15.1
Vermont	2015	626,088	747	119.3	10	1.6	150	24.0	104	16.6	105	16.8	482	77.0	9,064	1,447.7	2,034	324.9	6,834	1,091.5	196	31.3
	2016	624,594	989	158.3	14	2.2	178	28.5	124	19.9	106	17.0	691	110.6	10,602	1,697.4	2,103	336.7	8,217	1,315.6	282	45.1
	Percent change		+32.4	+32.7	+40.0	+40.3	18.7	+19.0	+19.2	+19.5	+1.0	+1.2	+43.4	+43.7	+17.0	+17.2	+3.4	+3.6	+20.2	+20.5	+43.9	+44.2
	2015	41,474,508	138,353	333.6	1,641	4.0	11,813	28.5	8,538	20.6	46,573	112.3	78,326	188.9	694,867	1,675.4	111,650	269.2	544,036	1,311.7	39,181	94.5

9.3.1.1 Simple version

This is straightforward to import as long as you don't care to organise the hierarchies of crimes and areas. For example, Conneticut is within the division New England, which itself is within the region Northeast, but if you don't need to express those relationships in the data then you can ignore the bold formatting.

The only slight snag is that the header cells in row 5 are blank. There is a header for the units "Rate per 100,000", but no header for the units "Count" – the cells in those positions are empty. It would be a problem if the cells didn't exist at all, because `behead("N", "unit")` wouldn't be able to associate data cells with missing header cells. Fortunately they do exist (because they have formatting), they are just empty or `NA`. To make sure they aren't ignored, use `drop_na = FALSE` in `behead()`, and then later fill the blanks in the `units` column with `"Count"`.

```
cells <-
  xlsx_cells(smungs::us_crime_2) %>%
  mutate(character = map_chr(character_formatted,
                             ~ ifelse(is.null(.x), character, .x$character[1])),
         character = str_replace_all(character, "\n", " "))

cells %>%
  dplyr::filter(row >= 4L) %>%
  select(row, col, data_type, character, numeric) %>%
  behead("NNW", "crime") %>%
  behead("N", "unit", drop_na = FALSE) %>%
  behead("WNW", "area") %>%
  behead("W", "year") %>%
  behead("W", "population") %>%
  dplyr::filter(year != "Percent change") %>%
  mutate(unit = if_else(unit == "", "Count", unit)) %>%
  select(row, data_type, numeric, unit, area, year, population, crime) %>%
```

```
  spatter(unit) %>%
  select(-row)
```

```
## # A tibble: 1,320 x 6
##    area                year  population crime       Count `Rate per  100,~
##    <chr>               <chr> <chr>      <chr>       <dbl>             <dbl>
##  1 United States Total 2015  320896618  Aggravate~ 7.64e5             238.
##  2 United States Total 2015  320896618  Burglary   1.59e6             495.
##  3 United States Total 2015  320896618  Larceny-t~ 5.72e6            1784.
##  4 United States Total 2015  320896618  Motor veh~ 7.13e5             222.
##  5 United States Total 2015  320896618  Murder an~ 1.59e4               4.9
##  6 United States Total 2015  320896618  Property ~ 8.02e6            2500.
##  7 United States Total 2015  320896618  Rape (leg~ 9.13e4              28.4
##  8 United States Total 2015  320896618  Rape (rev~ 1.26e5              39.3
##  9 United States Total 2015  320896618  Robbery    3.28e5             102.
## 10 United States Total 2015  320896618  Violent c~ 1.23e6             385.
## # ... with 1,310 more rows
```

9.3.1.2 Complex version

If you do mind about grouping states within divisions within regions, and crimes within categories, then you have more work to do using `enhead()` rather than `behead()`.

1. Select the header cells at each level of the hierarchy and store them in their own variables. For example, filter for the bold cells in row 4, which are the categories of crimes, and store them in the `categories` variable.
2. Select the data cells, and use `enhead()` to join them to the headers.

In fact the headers `unit`, `year`, `population` can be handled by `behead()`, because they aren't hierarchichal, so only the variables `category`, `crime`, `region`, `division` and `state` are handled by `enhead()`.

```
cells <-
  xlsx_cells(smungs::us_crime_2) %>%
  mutate(character = map_chr(character_formatted,
                             ~ ifelse(is.null(.x), character, .x$character[1])),
         character = str_replace_all(character, "\n", " "))

formats <- xlsx_formats(smungs::us_crime_2)

categories <-
  cells %>%
  dplyr::filter(row == 4L,
                data_type == "character",
                formats$local$font$bold[local_format_id]) %>%
  select(row, col, category = character)
categories
```

```
## # A tibble: 2 x 3
##     row   col category
##   <int> <int> <chr>
## 1     4     4 Violent crime
## 2     4    16 Property crime
```

```
crimes <-
  cells %>%
```

```
  dplyr::filter(row == 4L, data_type == "character") %>%
  mutate(character = if_else(character %in% categories$category,
                             "Total",
                             character)) %>%
  select(row, col, crime = character)
crimes
```

```
## # A tibble: 13 x 3
##      row   col crime
##    <int> <int> <chr>
##  1     4     1 Area
##  2     4     2 Year
##  3     4     3 Population
##  4     4     4 Total
##  5     4     6 Murder and  nonnegligent  manslaughter
##  6     4     8 Rape (revised definition)
##  7     4    10 Rape (legacy definition)
##  8     4    12 Robbery
##  9     4    14 Aggravated assault
## 10     4    16 Total
## 11     4    18 Burglary
## 12     4    20 Larceny-theft
## 13     4    22 Motor vehicle theft
```

```
regions <-
  cells %>%
  dplyr::filter(row >= 6L,
                col == 1L,
                data_type == "character",
                formats$local$font$bold[local_format_id]) %>%
  select(row, col, region = character)
regions
```

```
## # A tibble: 5 x 3
##     row   col region
##   <int> <int> <chr>
## 1     6     1 United States Total
## 2     9     1 Northeast
## 3    45     1 Midwest
## 4    90     1 South
## 5   153     1 West
```

```
divisions <-
  cells %>%
  dplyr::filter(row >= 6L,
                col == 1L,
                data_type == "character",
                !formats$local$font$bold[local_format_id],
                !str_detect(character, "^ {5}")) %>%
  select(row, col, division = character)
divisions
```

```
## # A tibble: 21 x 3
##      row   col division
##    <int> <int> <chr>
##  1    12     1 New England
```

```
##  2    33     1 Middle Atlantic
##  3    48     1 East North Central
##  4    66     1 West North Central
##  5    93     1 South Atlantic
##  6   123     1 East South Central
##  7   138     1 West South Central
##  8   156     1 Mountain
##  9   183     1 Pacific
## 10   201     1 Puerto Rico
## # ... with 11 more rows
```

```
states <-
  cells %>%
  dplyr::filter(row >= 6L,
                col == 1L,
                data_type == "character") %>%
  mutate(character = if_else(str_detect(character, "^ {5}"),
                             str_trim(character),
                             "Total")) %>%
  select(row, col, state = character)
states
```

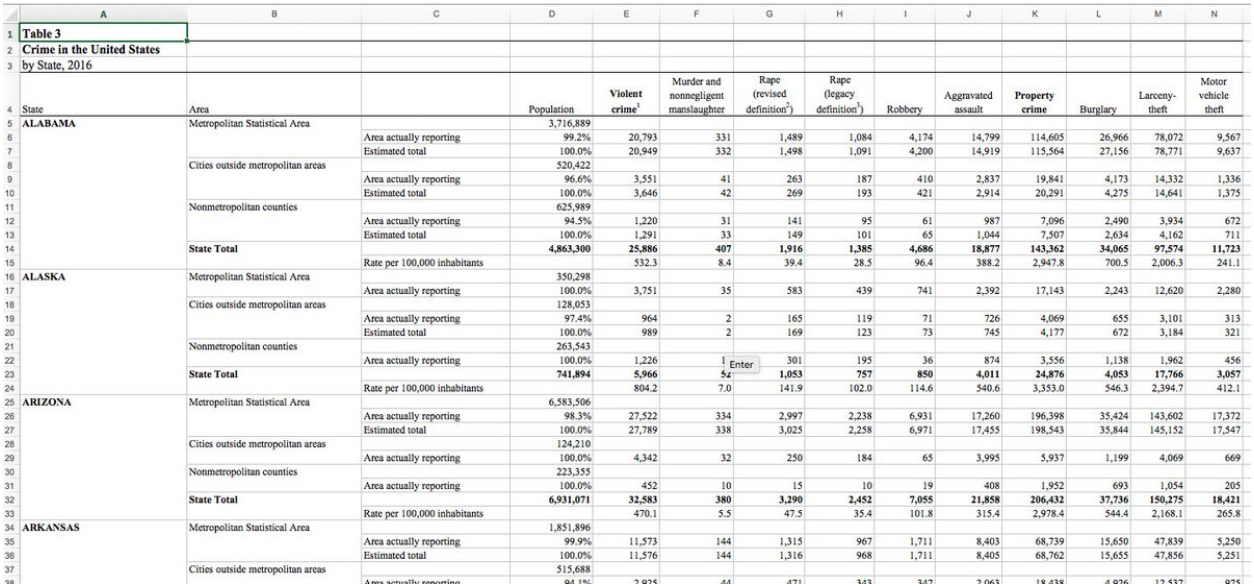
```
## # A tibble: 77 x 3
##      row   col state
##    <int> <int> <chr>
##  1     6     1 Total
##  2     9     1 Total
##  3    12     1 Total
##  4    15     1 Connecticut
##  5    18     1 Maine
##  6    21     1 Massachusetts
##  7    24     1 New Hampshire
##  8    27     1 Rhode Island
##  9    30     1 Vermont
## 10    33     1 Total
## # ... with 67 more rows
```

```
cells %>%
  dplyr::filter(row >= 5L, col >= 2L) %>%
  select(row, col, data_type, character, numeric) %>%
  behead("N", "unit") %>%
  behead("W", "year") %>%
  behead("W", "population") %>%
  enhead(categories, "NNW") %>%
  enhead(crimes, "NNW") %>%
  enhead(regions, "WNW") %>%
  enhead(divisions, "WNW", drop = FALSE) %>%
  enhead(states, "WNW", drop = FALSE) %>%
  dplyr::filter(year != "Percent change") %>%
  select(value = numeric, category, crime, region, division, state, year, population)
```

```
## # A tibble: 2,640 x 8
##      value category      crime      region division state year  population
##      <dbl> <chr>         <chr>      <chr>  <chr>    <chr> <chr> <chr>
##  1 42121   Violent crime Total      North~ New Eng~ Total 2015  14710229
##  2   286.  Violent crime Total      North~ New Eng~ Total 2015  14710229
```

```
##  3 41598   Violent crime Total      North~ New Eng~ Total 2016  14735525
##  4   282.  Violent crime Total      North~ New Eng~ Total 2016  14735525
##  5   326   Violent crime Murder an~ North~ New Eng~ Total 2015  14710229
##  6     2.2 Violent crime Murder an~ North~ New Eng~ Total 2015  14710229
##  7   292   Violent crime Murder an~ North~ New Eng~ Total 2016  14735525
##  8     2   Violent crime Murder an~ North~ New Eng~ Total 2016  14735525
##  9  4602   Violent crime Rape (rev~ North~ New Eng~ Total 2015  14710229
## 10    31.3 Violent crime Rape (rev~ North~ New Eng~ Total 2015  14710229
## # ... with 2,630 more rows
```

9.3.1.3 Table 3



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Table 3**													
2	**Crime in the United States**													
3	by State, 2016													
4	State	Area		Population	**Violent crime**[1]	Murder and nonnegligent manslaughter	Rape (revised definition[2])	Rape (legacy definition[3])	Robbery	Aggravated assault	**Property crime**	Burglary	Larceny-theft	Motor vehicle theft
5	**ALABAMA**	Metropolitan Statistical Area		3,716,889										
6			Area actually reporting	99.2%	20,793	331	1,489	1,084	4,174	14,799	114,605	26,966	78,072	9,567
7			Estimated total	100.0%	20,949	332	1,498	1,091	4,200	14,919	115,564	27,156	78,771	9,637
8		Cities outside metropolitan areas		520,422										
9			Area actually reporting	96.6%	3,551	41	263	187	410	2,837	19,841	4,173	14,332	1,336
10			Estimated total	100.0%	3,646	42	269	193	421	2,914	20,291	4,275	14,641	1,375
11		Nonmetropolitan counties		625,989										
12			Area actually reporting	94.5%	1,220	31	141	95	61	987	7,096	2,490	3,934	672
13			Estimated total	100.0%	1,291	33	149	101	65	1,044	7,507	2,634	4,162	711
14		**State Total**		**4,863,300**	**25,886**	**407**	**1,916**	**1,385**	**4,686**	**18,877**	**143,362**	**34,065**	**97,574**	**11,723**
15			Rate per 100,000 inhabitants		532.3	8.4	39.4	28.5	96.4	388.2	2,947.8	700.5	2,006.3	241.1
16	**ALASKA**	Metropolitan Statistical Area		350,298										
17			Area actually reporting	100.0%	3,751	35	583	439	741	2,392	17,143	2,243	12,620	2,280
18		Cities outside metropolitan areas		128,053										
19			Area actually reporting	97.4%	964	2	165	119	71	726	4,069	655	3,101	313
20			Estimated total	100.0%	989	2	169	123	73	745	4,177	672	3,184	321
21		Nonmetropolitan counties		263,543										
22			Area actually reporting	100.0%	1,226	1	301	195	36	874	3,556	1,138	1,962	456
23		**State Total**		**741,894**	**5,966**	**5**	**1,053**	**757**	**850**	**4,011**	**24,876**	**4,053**	**17,766**	**3,057**
24			Rate per 100,000 inhabitants		804.2	7.0	141.9	102.0	114.6	540.6	3,353.0	546.3	2,394.7	412.1
25	**ARIZONA**	Metropolitan Statistical Area		6,583,506										
26			Area actually reporting	98.3%	27,522	334	2,997	2,238	6,931	17,260	196,398	35,424	143,602	17,372
27			Estimated total	100.0%	27,789	338	3,025	2,258	6,971	17,455	198,543	35,844	145,152	17,547
28		Cities outside metropolitan areas		124,210										
29			Area actually reporting	100.0%	4,342	32	250	184	65	3,995	5,937	1,199	4,069	669
30		Nonmetropolitan counties		223,355										
31			Area actually reporting	100.0%	452	10	15	10	19	408	1,952	693	1,054	205
32		**State Total**		**6,931,071**	**32,583**	**380**	**3,290**	**2,452**	**7,055**	**21,858**	**206,432**	**37,736**	**150,275**	**18,421**
33			Rate per 100,000 inhabitants		470.1	5.5	47.5	35.4	101.8	315.4	2,978.4	544.4	2,168.1	265.8
34	**ARKANSAS**	Metropolitan Statistical Area		1,851,896										
35			Area actually reporting	99.9%	11,573	144	1,315	967	1,711	8,403	68,739	15,650	47,839	5,250
36			Estimated total	100.0%	11,576	144	1,316	968	1,711	8,405	68,762	15,655	47,856	5,251
37		Cities outside metropolitan areas		515,688										

This table is confusing to humans, let alone computers. The `Population` column seems to belong to a different table altogether, so that's how we'll treat it.

1. Import the `Population` column and the state/area headers to the left.
2. Import the crime-related column headers, and the state/area headers to the left.
3. Join the two datasets.

The `statistic` header ends up having blank values due to the cells being blank, so these are manually filled in.

The hierarchy of crime (e.g. 'robbery' is within 'violent crime') is ignored. That would be handled in the same way as for Table 2.

```
cells <-
  xlsx_cells(smungs::us_crime_3) %>%
  mutate(character = map_chr(character_formatted,
                             ~ ifelse(is.null(.x), character, .x$character[1])),
         character = str_replace_all(character, "\n", " "))

population <-
  cells %>%
  dplyr::filter(row >= 5L, col <= 4L) %>%
  behead("WNW", "state") %>%
  behead("WNW", "area") %>%
```

```
  behead("W", "statistic", drop_na = FALSE) %>%
  mutate(statistic = case_when(is.na(statistic) ~ "Population",
                               statistic == "" ~ "Population",
                               TRUE ~ str_trim(statistic))) %>%
  dplyr::filter(data_type == "numeric",
                !str_detect(area, regex("total", ignore_case = TRUE)),
                statistic != "Estimated total") %>%
  select(data_type, numeric, state, area, statistic) %>%
  spatter(statistic)

crime <-
  cells %>%
  dplyr::filter(row >= 4, col != 5L) %>%
  behead("WNW", "state") %>%
  behead("WNW", "area") %>%
  behead("W", "statistic", formatters = list(character = str_trim)) %>%
  behead("N", "crime") %>%
  dplyr::filter(data_type == "numeric",
                !str_detect(area, regex("total", ignore_case = TRUE)),
                !is.na(statistic),
                statistic != "") %>%
  mutate(statistic = case_when(statistic == "Area actually reporting" ~ "Actual",
                               statistic == "Estimated total" ~ "Estimated")) %>%
  select(data_type, numeric, state, area, statistic, crime) %>%
  spatter(statistic)

left_join(population, crime)
```

```
## Joining, by = c("state", "area")
```

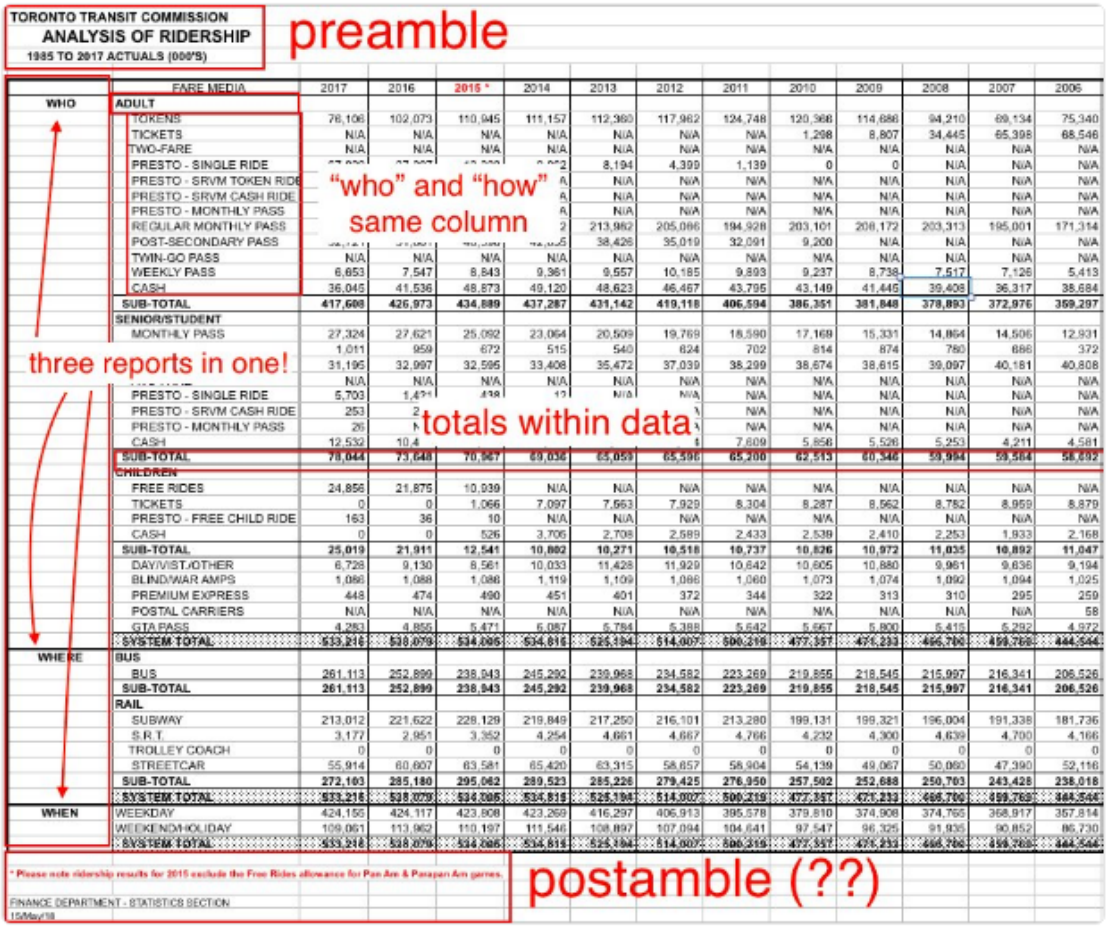
```
## # A tibble: 1,480 x 7
##    state   area     `Area actually r~ Population crime    Actual Estimated
##    <chr>   <chr>                <dbl>      <dbl> <chr>     <dbl>     <dbl>
##  1 ALABAMA Cities ~             0.966     520422 Aggrav~ 2.84e+3      2914
##  2 ALABAMA Cities ~             0.966     520422 Burgla~ 4.17e+3      4275
##  3 ALABAMA Cities ~             0.966     520422 Larcen~ 1.43e+4     14641
##  4 ALABAMA Cities ~             0.966     520422 Motor ~ 1.34e+3      1375
##  5 ALABAMA Cities ~             0.966     520422 Murder~ 4.10e+1        42
##  6 ALABAMA Cities ~             0.966     520422 Popula~ 9.66e-1         1
##  7 ALABAMA Cities ~             0.966     520422 Proper~ 1.98e+4     20291
##  8 ALABAMA Cities ~             0.966     520422 Rape (~ 1.87e+2       193
##  9 ALABAMA Cities ~             0.966     520422 Rape (~ 2.63e+2       269
## 10 ALABAMA Cities ~             0.966     520422 Robbery 4.10e+2       421
## # ... with 1,470 more rows
```

9.4 Toronto Transit Commission

Sharla Gelfand
@sharlagelfand

Follow

new #rstats blog post! Tidying more @Open_TO data, this time exploring the TTC (and learning a lot about it, Toronto, and Ontario in the process 😍)
sharlagelfand.netlify.com/posts/tidy-ttc/



TORONTO TRANSIT COMMISSION
ANALYSIS OF RIDERSHIP
1985 TO 2017 ACTUALS (000'S)

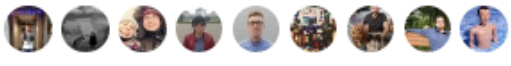
	FARE MEDIA	2017	2016	2015 *	2014	2013	2012	2011	2010	2009	2008	2007	2006
WHO	ADULT												
	TOKENS	76,106	102,073	110,945	111,157	112,360	117,962	124,748	120,366	114,686	94,210	69,134	75,340
	TICKETS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,298	8,807	34,445	65,398	68,546
	TWO-FARE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PRESTO - SINGLE RIDE					8,194	4,399	1,139	0	0	N/A	N/A	N/A
	PRESTO - SRVM TOKEN RIDE					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PRESTO - SRVM CASH RIDE					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PRESTO - MONTHLY PASS					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	REGULAR MONTHLY PASS					213,982	205,086	194,928	203,101	208,172	203,313	195,001	171,314
	POST-SECONDARY PASS					38,426	35,019	32,091	9,200	N/A	N/A	N/A	N/A
	TWIN-GO PASS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	WEEKLY PASS	6,653	7,547	8,843	9,361	9,557	10,185	9,893	9,237	8,738	7,517	7,126	5,413
	CASH	36,045	41,536	48,873	49,120	48,623	46,467	43,795	43,149	41,445	39,408	36,317	38,684
	SUB-TOTAL	417,608	426,973	434,889	437,287	431,142	419,118	406,594	386,351	381,848	378,893	372,976	359,297
	SENIOR/STUDENT												
	MONTHLY PASS	27,324	27,621	25,092	23,064	20,509	19,769	18,590	17,169	15,331	14,864	14,506	12,931
		1,011	959	672	515	540	624	702	814	874	780	686	372
		31,195	32,997	32,595	33,408	35,472	37,039	38,299	38,674	38,615	39,097	40,181	40,808
		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PRESTO - SINGLE RIDE	5,703	1,47	438	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PRESTO - SRVM CASH RIDE	253	2					N/A	N/A	N/A	N/A	N/A	N/A
	PRESTO - MONTHLY PASS	26	N					N/A	N/A	N/A	N/A	N/A	N/A
	CASH	12,532	10,4					7,809	5,856	5,526	5,253	4,211	4,581
	SUB-TOTAL	78,044	73,648	70,967	69,036	65,059	65,596	65,200	62,513	60,346	59,994	59,584	58,692
	CHILDREN												
	FREE RIDES	24,856	21,875	10,939	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TICKETS	0	0	1,066	7,097	7,563	7,929	8,304	8,287	8,562	8,782	8,959	8,879
	PRESTO - FREE CHILD RIDE	163	36	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	CASH	0	0	526	3,705	2,708	2,589	2,433	2,539	2,410	2,253	1,933	2,168
	SUB-TOTAL	25,019	21,911	12,541	10,802	10,271	10,518	10,737	10,826	10,972	11,035	10,892	11,047
	DAY/VISIT/OTHER	6,728	9,130	8,561	10,033	11,428	11,929	10,642	10,605	10,880	9,961	9,636	9,194
	BLIND/WAR AMPS	1,086	1,088	1,086	1,119	1,109	1,086	1,060	1,073	1,074	1,092	1,094	1,025
	PREMIUM EXPRESS	448	474	490	451	401	372	344	322	313	310	295	259
	POSTAL CARRIERS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	58
	GTA PASS	4,283	4,855	5,471	6,087	5,784	5,388	5,642	5,667	5,800	5,415	5,292	4,972
	SYSTEM TOTAL	533,216	538,079	534,095	534,815	525,194	514,007	500,219	477,357	471,233	466,700	459,765	444,544
WHERE	BUS												
	BUS	261,113	252,899	238,943	245,292	239,968	234,582	223,269	219,855	218,545	215,997	216,341	206,526
	SUB-TOTAL	261,113	252,899	238,943	245,292	239,968	234,582	223,269	219,855	218,545	215,997	216,341	206,526
	RAIL												
	SUBWAY	213,012	221,622	228,129	219,849	217,250	216,101	213,280	199,131	199,321	196,004	191,338	181,736
	S.R.T.	3,177	2,951	3,352	4,254	4,661	4,667	4,766	4,232	4,300	4,639	4,700	4,166
	TROLLEY COACH	0	0	0	0	0	0	0	0	0	0	0	0
	STREETCAR	55,914	60,607	63,581	65,420	63,315	58,657	58,904	54,139	49,067	50,060	47,390	52,116
	SUB-TOTAL	272,103	285,180	295,062	289,523	285,226	279,425	276,950	257,502	252,688	250,703	243,428	238,018
	SYSTEM TOTAL	533,216	538,079	534,095	534,815	525,194	514,007	500,219	477,357	471,233	466,700	459,765	444,544
WHEN	WEEKDAY	424,156	424,117	423,808	423,269	416,297	406,913	395,578	379,810	374,908	374,765	368,917	357,814
	WEEKEND/HOLIDAY	109,061	113,962	110,197	111,546	108,897	107,094	104,641	97,547	96,325	91,935	90,852	86,730
	SYSTEM TOTAL	533,216	538,079	534,095	534,815	525,194	514,007	500,219	477,357	471,233	466,700	459,765	444,544

* Please note ridership results for 2015 exclude the Free Rides allowance for Pan Am & Parapan Am games.

FINANCE DEPARTMENT - STATISTICS SECTION
15/May/18

6:08 AM - 16 May 2018

30 Retweets **103** Likes



This table shows the number of trips recorded on the Toronto Transit Commission per year, by type of ticket, person, vehicle, and weeday/weekend/holiday. Sharla Gelfand's annotated screenshot explains the structure.

9.4.1 The full code listing

```
cells <-
  xlsx_cells(smungs::toronto_transit) %>%
  dplyr::filter(!is_blank, row >= 6)

fare <-
  cells %>%
  dplyr::filter(col == 2,
                !str_detect(character, "^ "),
                !str_detect(character, "TOTAL")) %>%
  select(row, col, fare = character)

cells %>%
  behead("N", "year", formatters = list(character = str_trim)) %>%
  behead("WNW", "context") %>%
  behead("W", "media", formatters = list(character = str_trim)) %>%
  enhead(fare, "WNW") %>%
  dplyr::filter(!str_detect(media, "TOTAL")) %>%
  separate(year, c("year", "note"), sep = " ", fill = "right") %>%
  select(year, context, fare, media, count = numeric)
```

```
## # A tibble: 1,188 x 5
##    year  context fare  media   count
##    <chr> <chr>   <chr> <chr>   <dbl>
##  1 2017  WHO     ADULT TOKENS  76106
##  2 2016  WHO     ADULT TOKENS 102073
##  3 2015  WHO     ADULT TOKENS 110945
##  4 2014  WHO     ADULT TOKENS 111157
##  5 2013  WHO     ADULT TOKENS 112360
##  6 2012  WHO     ADULT TOKENS 117962
##  7 2011  WHO     ADULT TOKENS 124748
##  8 2010  WHO     ADULT TOKENS 120366
##  9 2009  WHO     ADULT TOKENS 114686
## 10 2008  WHO     ADULT TOKENS  94210
## # ... with 1,178 more rows
```

9.4.2 Step by step

Although the annotations point out that there are really three separate tables (`WHO`, `WHERE` and `WHEN`), they can be imported as one.

Column 2 has two levels of headers in it: the fare in bold ("ADULT", "BUS", etc.), and the media used to pay for it indented by a few spaces ("TOKENS", "WEEKLY PASS", etc.).

Because `behead()` can't distinguish between different levels of headers in the same column, we need to put the bold fare headers into a separate variable on their own, and `enhead()` them back onto the rest of the table later.

Unfortunately the fare headers in the "WHEN" context aren't bold, so rather than filter for bold headers, instead we filter for headers that aren't indented by spaces. We also filter out any "TOTAL" headers.

```
cells <-
  xlsx_cells(smungs::toronto_transit) %>%
  dplyr::filter(!is_blank, row >= 6)

fare <-
  cells %>%
  dplyr::filter(col == 2,
                !str_detect(character, "^ "), # Filter out indented headers
                !str_detect(character, "TOTAL")) %>% # Filteroout totals
  select(row, col, fare = character)
fare
```

```
## # A tibble: 7 x 3
##     row   col fare
##   <int> <int> <chr>
## 1     7     2 ADULT
## 2    21     2 SENIOR/STUDENT
## 3    31     2 CHILDREN
## 4    43     2 BUS
## 5    46     2 RAIL
## 6    53     2 WEEKDAY
## 7    54     2 WEEKEND/HOLIDAY
```

```
ttc <-
  cells %>%
  behead("N", "year") %>%
  behead("WNW", "context") %>%
  behead("W", "media") %>%
  enhead(fare, "WNW") %>%
  dplyr::filter(!str_detect(media, "TOTAL")) %>%
  select(year, context, fare, media, count = numeric)
ttc
```

```
## # A tibble: 1,188 x 5
##    year      context fare  media          count
##    <chr>     <chr>   <chr> <chr>          <dbl>
##  1 2017      WHO     ADULT "     TOKENS"  76106
##  2 2016      WHO     ADULT "     TOKENS" 102073
##  3 " 2015 *" WHO     ADULT "     TOKENS" 110945
##  4 2014      WHO     ADULT "     TOKENS" 111157
##  5 2013      WHO     ADULT "     TOKENS" 112360
##  6 2012      WHO     ADULT "     TOKENS" 117962
##  7 2011      WHO     ADULT "     TOKENS" 124748
##  8 2010      WHO     ADULT "     TOKENS" 120366
##  9 2009      WHO     ADULT "     TOKENS" 114686
## 10 2008      WHO     ADULT "     TOKENS"  94210
## # ... with 1,178 more rows
```

There's a bit more cosmetic cleaning to do. The indentation can be trimmed from the `media` and the `year` headers, and the asterisk removed from the year `2015 *`.

```
ttc %>%
  mutate(year = str_trim(year), media = str_trim(media)) %>%
  separate(year, c("year", "note"), sep = " ", fill = "right") %>%
  select(-note)
```

```
## # A tibble: 1,188 x 5
##    year  context fare  media   count
##    <chr> <chr>   <chr> <chr>   <dbl>
##  1 2017  WHO     ADULT TOKENS  76106
##  2 2016  WHO     ADULT TOKENS 102073
##  3 2015  WHO     ADULT TOKENS 110945
##  4 2014  WHO     ADULT TOKENS 111157
##  5 2013  WHO     ADULT TOKENS 112360
##  6 2012  WHO     ADULT TOKENS 117962
##  7 2011  WHO     ADULT TOKENS 124748
##  8 2010  WHO     ADULT TOKENS 120366
##  9 2009  WHO     ADULT TOKENS 114686
## 10 2008  WHO     ADULT TOKENS  94210
## # ... with 1,178 more rows
```