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.

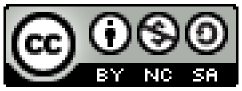


Figure 1: Creative Commons License

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 two are my own: tidyxl and unpivotr, and you will need the latest versions from CRAN.

```
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(readr)
library(readxl)
library(tidyxl)
library(unpivotr)
```

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.

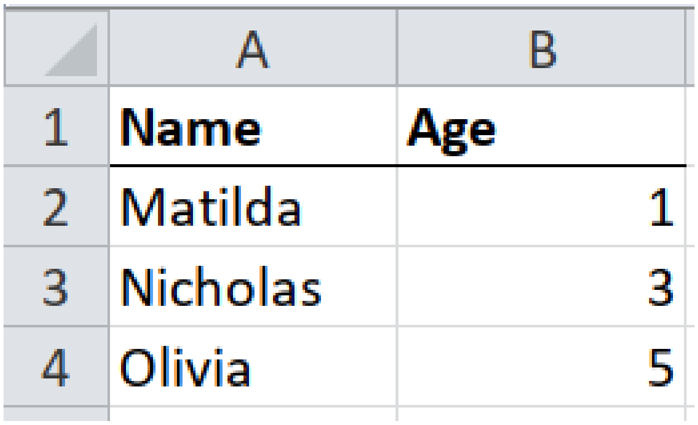
```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
```

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.

```r
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.

```r
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.

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

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

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

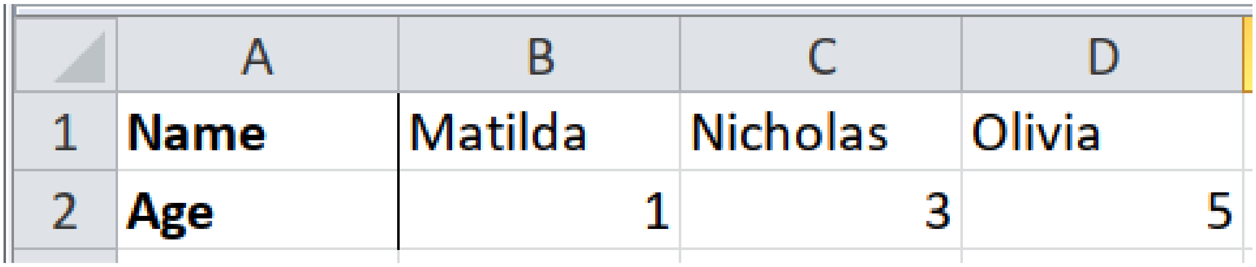
```
## # A tibble: 3 x 2
##   X__1      X__2
##   <chr>    <dbl>
## 1 Matilda      1
## 2 Nicholas     3
## 3 Olivia       5
```

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()
```

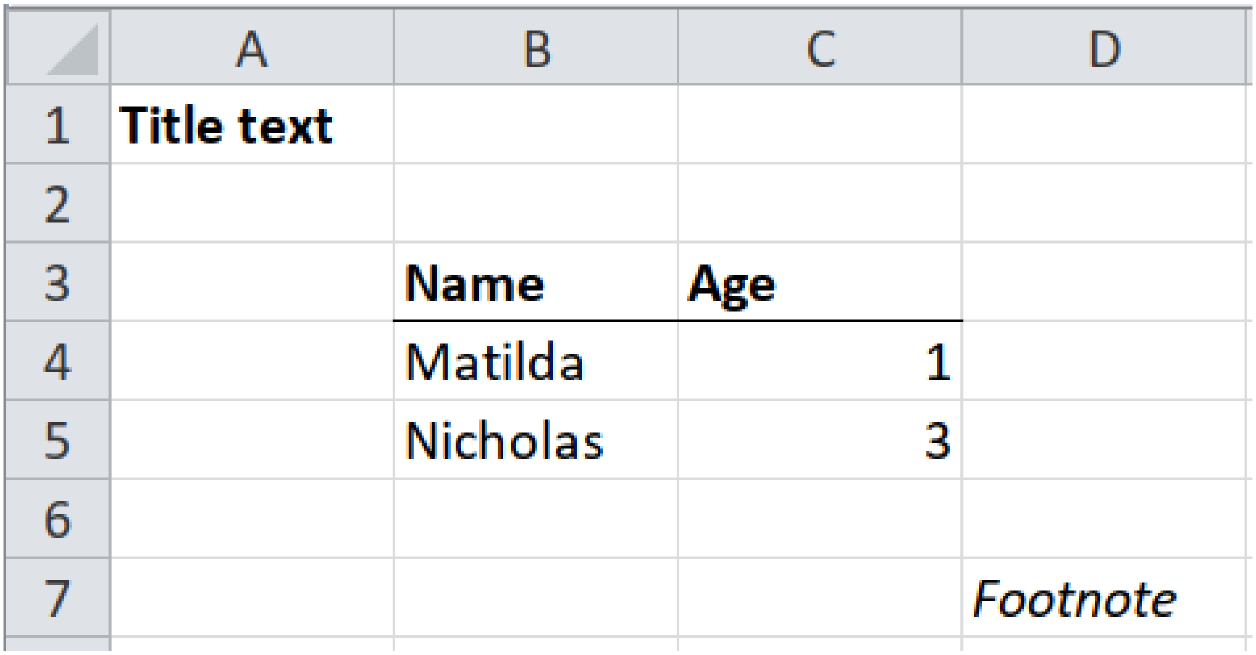
```
## # A tibble: 3 x 2
##   Name     Age  
##   <chr>    <chr>
## 1 Matilda  1    
## 2 Nicholas 3    
## 3 Olivia   5    
```

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)
```

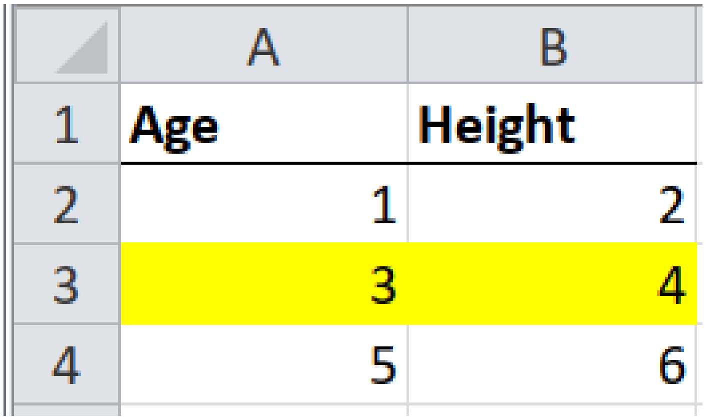
```
## # A tibble: 2 x 2
##   Name       Age
##   <chr>    <dbl>
## 1 Matilda      1
## 2 Nicholas     3
```

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>
```

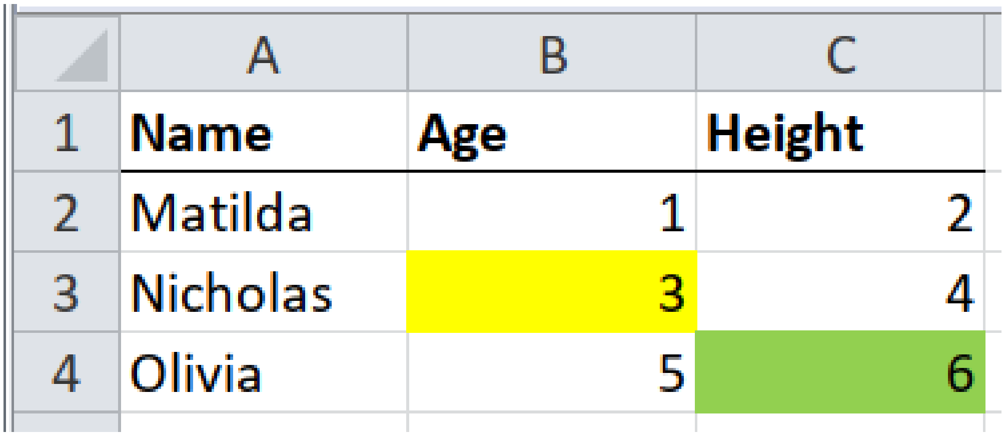
Note that the fill colour is expressed as an RGB value with transparency in the first two letters, e.g. `FFFFFF00` is `FF` (opaque), with `FFFF00` (yellow).

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"))
```

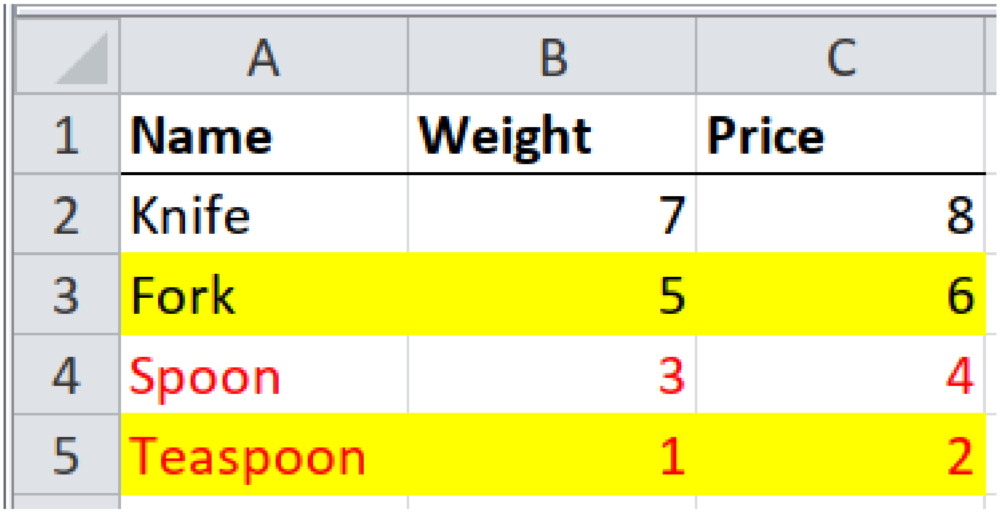
```
## # A tibble: 6 x 6
##     row   col Name     variable value fill_colour
##   <int> <int> <chr>    <chr>    <dbl> <chr>
## 1     2     2 Matilda  Age          1 <NA>
## 2     2     3 Matilda  Height       2 <NA>
## 3     3     2 Nicholas Age          3 FFFFFF00
## 4     3     3 Nicholas Height 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

```r
# `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)
```

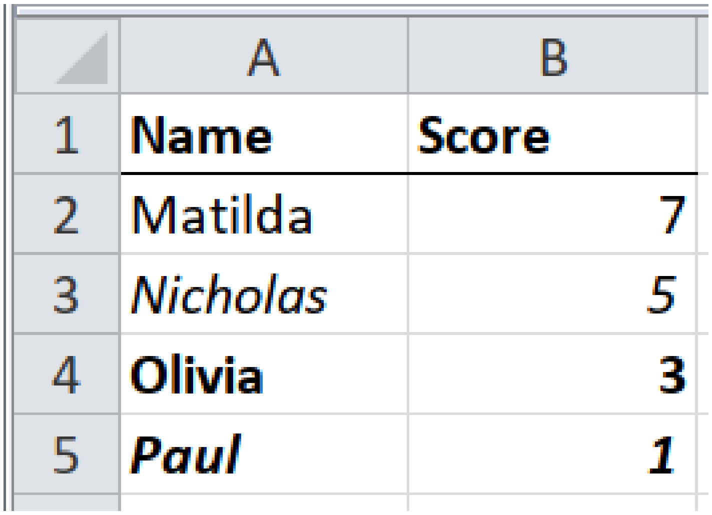
```
## # A tibble: 4 x 5
##   Name     Weight Price fill_colour font_colour
##   <chr>     <dbl> <dbl> <chr>       <chr>
## 1 Knife         7     8 <NA>        FF000000
## 2 Fork          5     6 FFFFFF00    FF000000
## 3 Spoon         3     4 <NA>        FFFF0000
## 4 Teaspoon      1     2 FFFFFF00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

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

```r
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()`.

```r
# 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
```

```r
# 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)
```

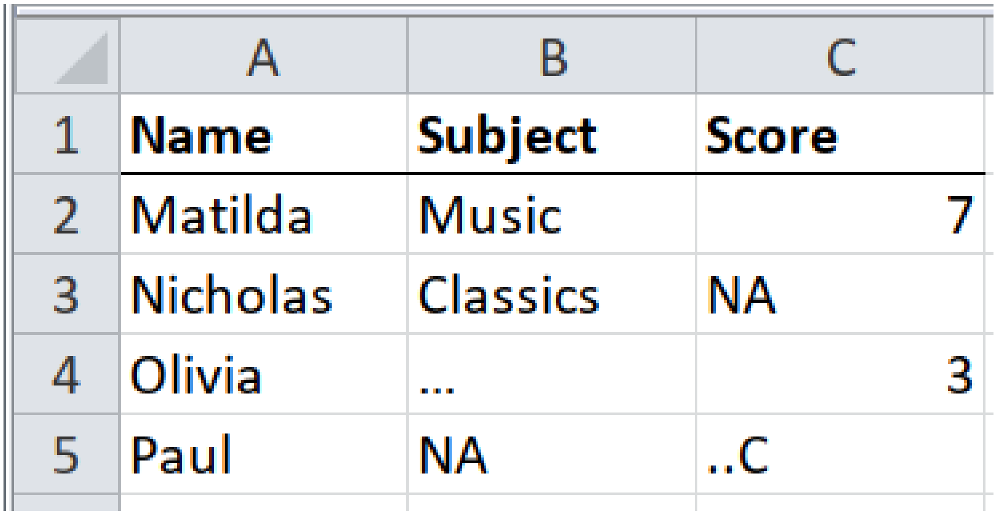
```
## # A tibble: 4 x 5
##   Name     Score bold  italic grade
##   <chr>    <dbl> <lgl> <lgl>  <chr>
## 1 Matilda      7 FALSE FALSE  good
## 2 Nicholas     5 FALSE TRUE   satisfactory
## 3 Olivia       3 TRUE  FALSE  poor
## 4 Paul         1 TRUE  TRUE   fail
```

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
```

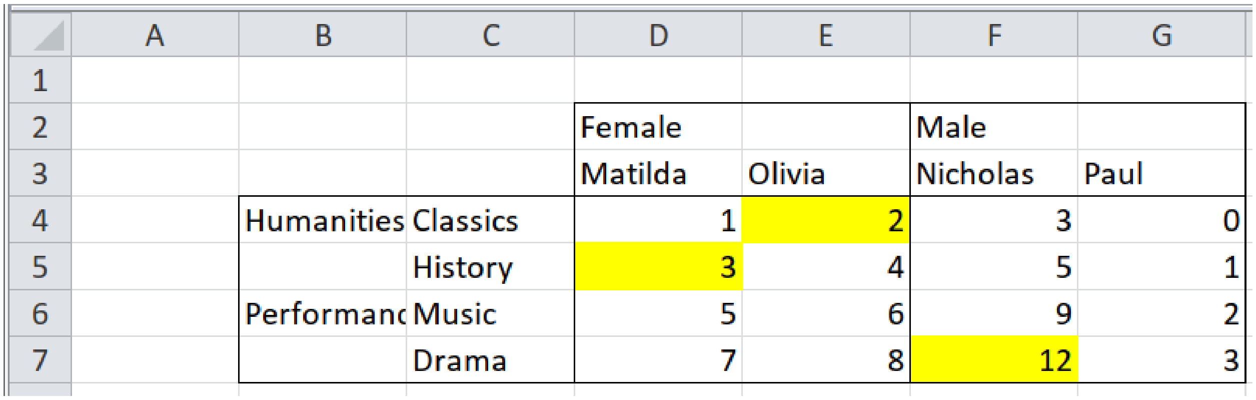
Here's another version using only tidyxl and unpivotr, which provides `isolate_sentinels()` to make this much more straightforward.

```
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.

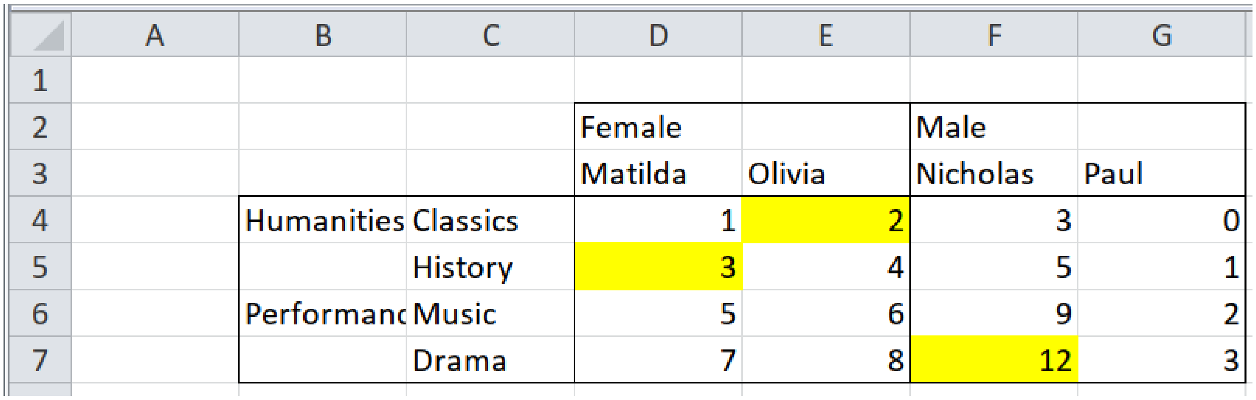
To a human it is intuitive that the cells below and to the right of the header `Male` represent males, and that ones to the right of and below the header `Postgraduate qualification` represent people with postgraduate qualifications, but it isn't so obvious to the computer. How would the computer know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

```r
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`)
```

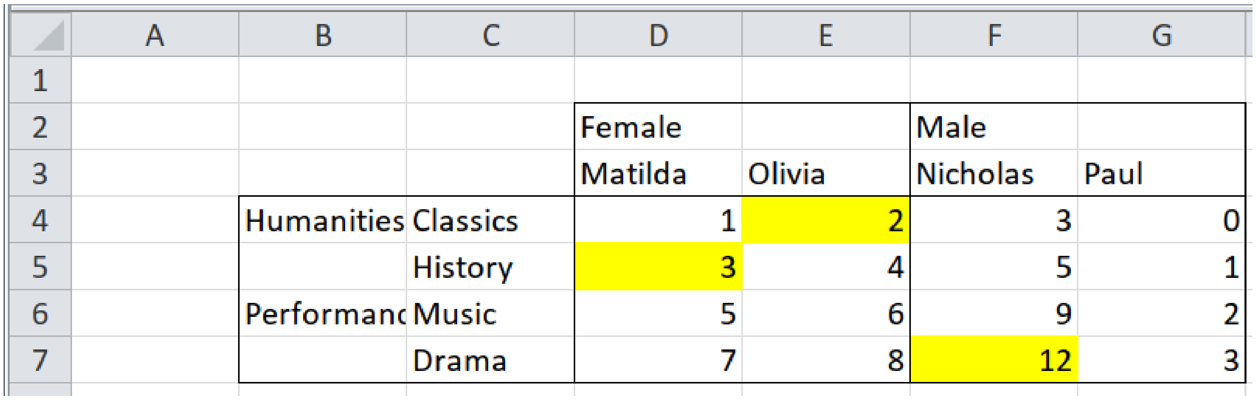
```
## # A tibble: 16 x 7
##      row   col data_type character numeric sex    name
##    <int> <int> <chr>     <chr>       <dbl> <chr>  <chr>
##  1     4     4 numeric   <NA>            1 Female Matilda
##  2     4     5 numeric   <NA>            2 Female Olivia
##  3     5     4 numeric   <NA>            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



	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

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.

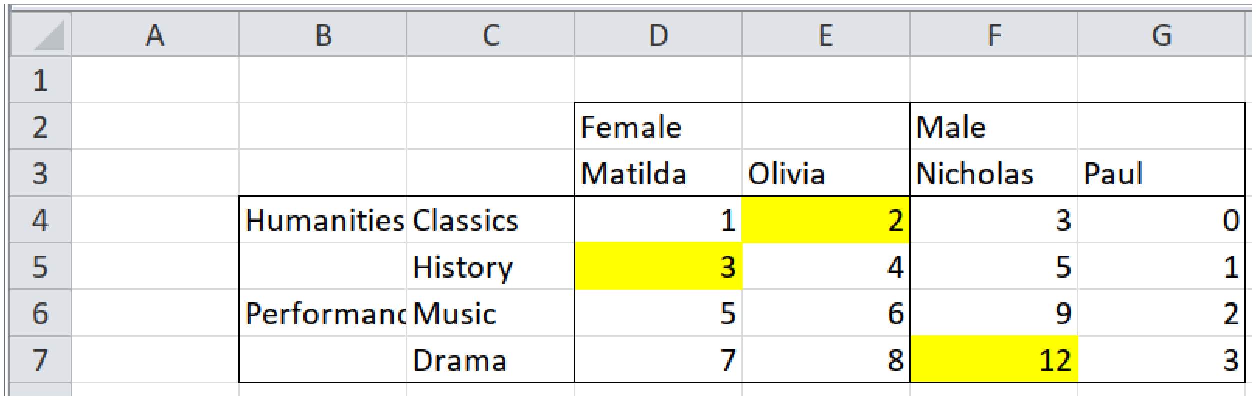
```
path <- system.file("extdata", "worked-examples.xlsx", package = "unpivotr")
all_cells <-
  xlsx_cells(path, sheets = "pivot-annotations") %>%
  dplyr::filter(!is_blank) %>%
  select(row, col, data_type, character, numeric) %>%
  print()
```

```
## # 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`.

```r
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         "FFFFFF00" "FF92D050" "FFFFFF00" NA         NA
## [13] "FFFFFF00" NA         NA         NA         NA         NA
## [19] NA         NA         "FFFFFF00" "FFFFFF00" NA         NA
## [25] "FFFFFF00" NA         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         NA         NA         NA         "FFFFC7CE"
## [61] 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>
```

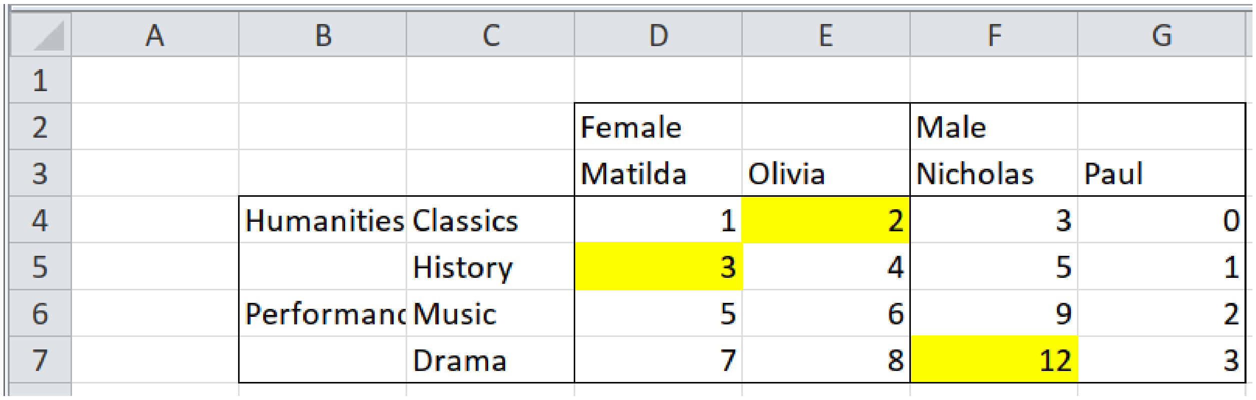
3.2 Complex unpivoting

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")
```

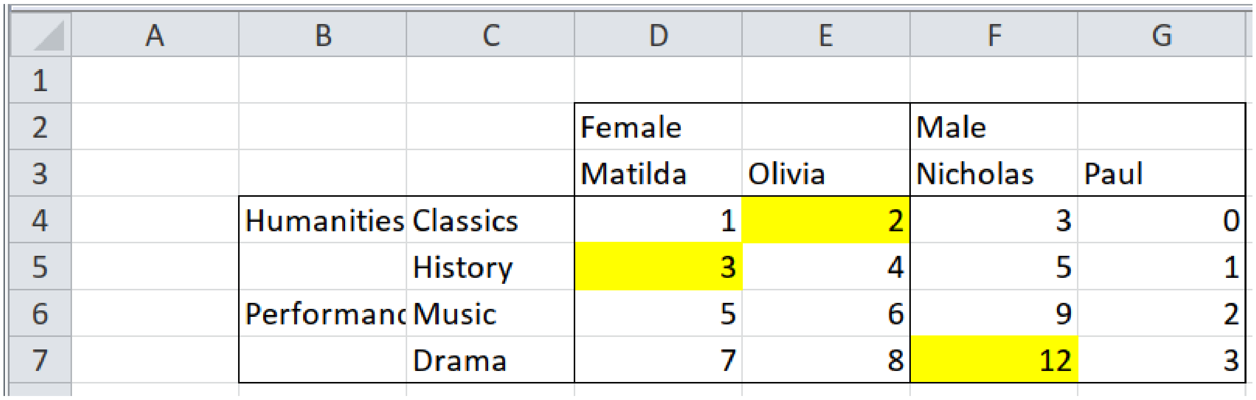
```
## # A tibble: 16 x 4
##      row   col score sex
##    <int> <int> <dbl> <chr>
##  1     4     4     1 Female
##  2     4     5     2 Female
##  3     5     4     3 Female
##  4     5     5     4 Female
##  5     6     4     5 Female
##  6     6     5     6 Female
##  7     7     4     7 Female
##  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.

```r
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
```

```r
# 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
```

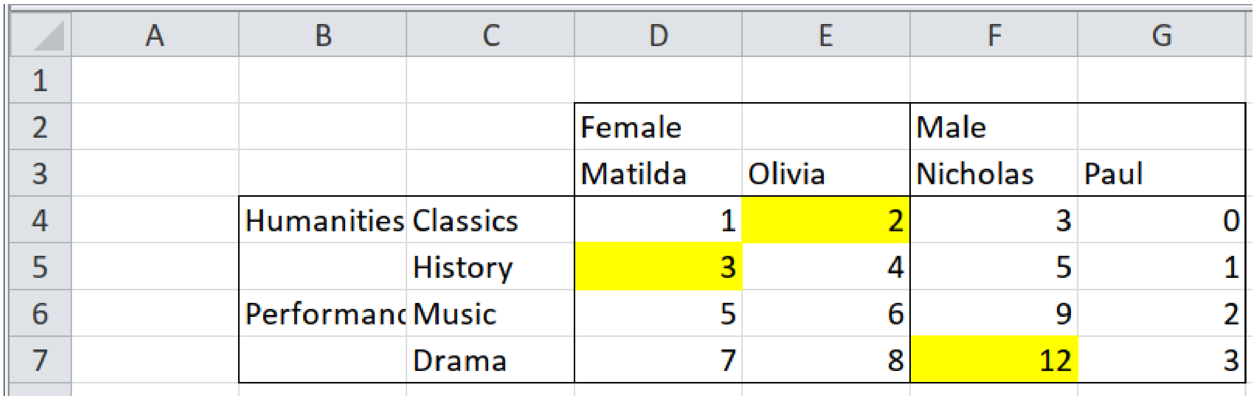
```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # '`character` column.
second_header_col
```

```
## # 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.

```r
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
```

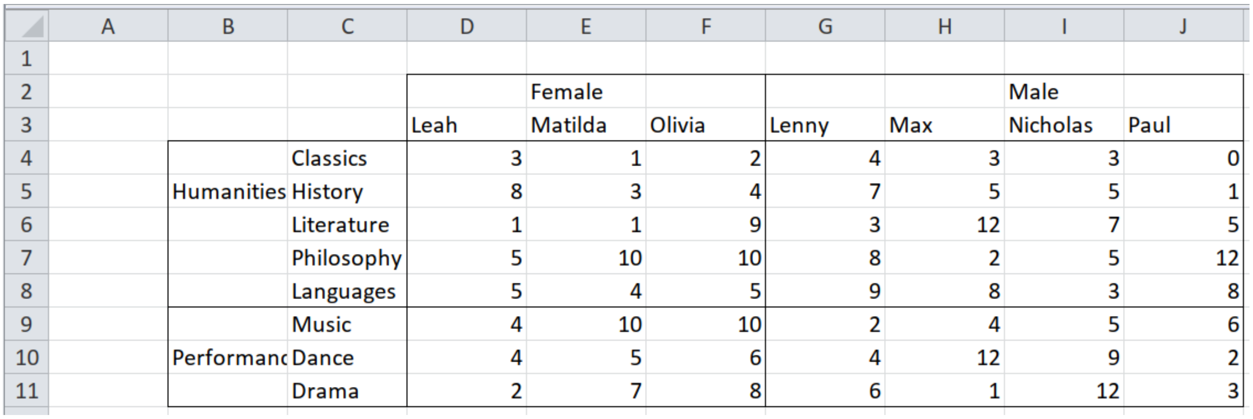
```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # '`character` column.
second_header_col
```

```
## # 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



	A	B	C	D	E	F	G	H	I	J
1										
2					Female				Male	
3				Leah	Matilda	Olivia	Lenny	Max	Nicholas	Paul
4			Classics	3	1	2	4	3	3	0
5		Humanities	History	8	3	4	7	5	5	1
6			Literature	1	1	9	3	12	7	5
7			Philosophy	5	10	10	8	2	5	12
8			Languages	5	4	5	9	8	3	8
9			Music	4	10	10	2	4	5	6
10		Performanc	Dance	4	5	6	4	12	9	2
11			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
```

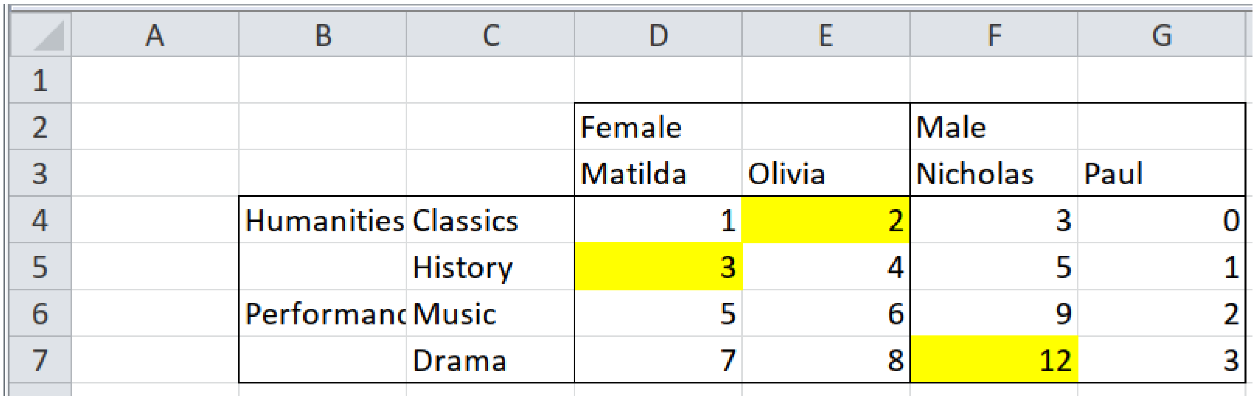
```
second_header_col <-
  dplyr::filter(all_cells, col == 3) %>%
  select(row, col, subject = character)
  # The title of this header is 'subject'
  # The cells are text cells (`"history"`, etc.) so take the value in the
  # '`character` column.
second_header_col
```

```
## # 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
```

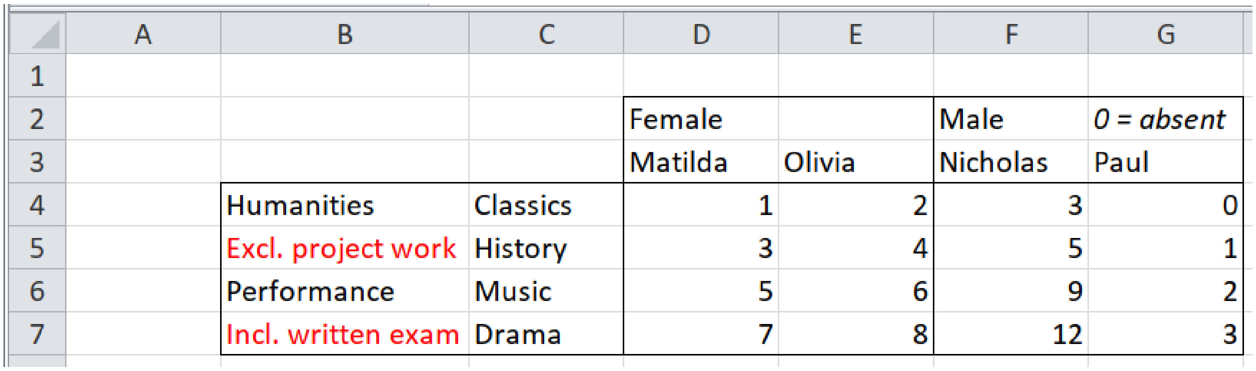
```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is exam scores in certain subjects, so give the data that title.
  # The data is numeric, so select only that 'value'.  If some of the data was
  # also text or true/false, then you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

```r
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] 11 12 13 39 40
```

```r
# 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] 39
```

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

```
## [1] 11 12 13 39 40
```

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              17
##  2     2     6 Male            NA              17
##  3     2     7 0 = absent      NA              38
##  4     3     4 Matilda         NA              19
##  5     3     5 Olivia          NA              20
##  6     3     6 Nicholas        NA              19
##  7     3     7 Paul            NA              20
##  8     4     2 Humanities      NA              17
##  9     4     3 Classics        NA              18
## 10     4     4 <NA>             1              32
## # ... 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
```

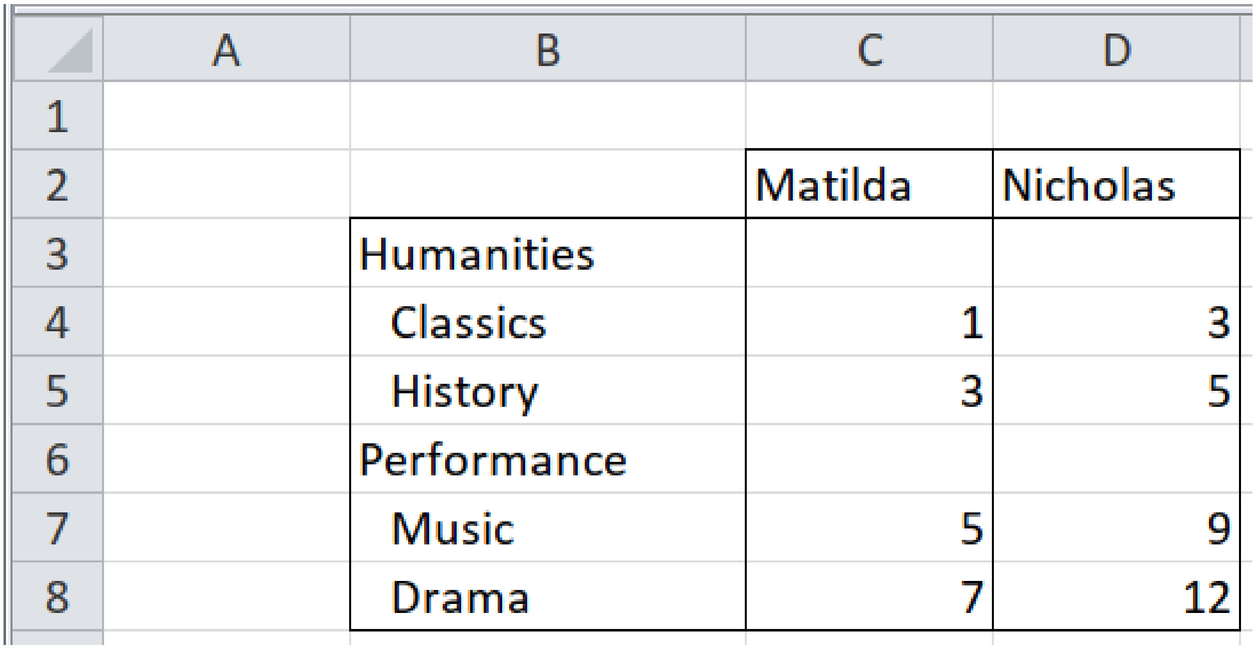
```
## # A tibble: 2 x 3
##     row   col qualification
##   <int> <int> <chr>
## 1     4     2 Humanities
## 2     6     2 Performance
```

```
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 44 46 47 48
## [47] 49 50 51 52 53 54 55 56 57 58 59 60 61
```

```
indent1
```

```
## [1] 43 45
```

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              17
##  2     2     4 character Nicholas         NA              41
##  3     3     2 character Humanities       NA              17
##  4     4     2 character Classics         NA              43
##  5     4     3 numeric   <NA>              1              19
##  6     4     4 numeric   <NA>              3              44
##  7     5     2 character History          NA              43
##  8     5     3 numeric   <NA>              3              19
##  9     5     4 numeric   <NA>              5              44
## 10     6     2 character Performance      NA              19
## 11     7     2 character Music            NA              43
## 12     7     3 numeric   <NA>              5              19
## 13     7     4 numeric   <NA>              9              44
## 14     8     2 character Drama            NA              45
## 15     8     3 numeric   <NA>              7              23
## 16     8     4 numeric   <NA>             12              46
```

```
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
```

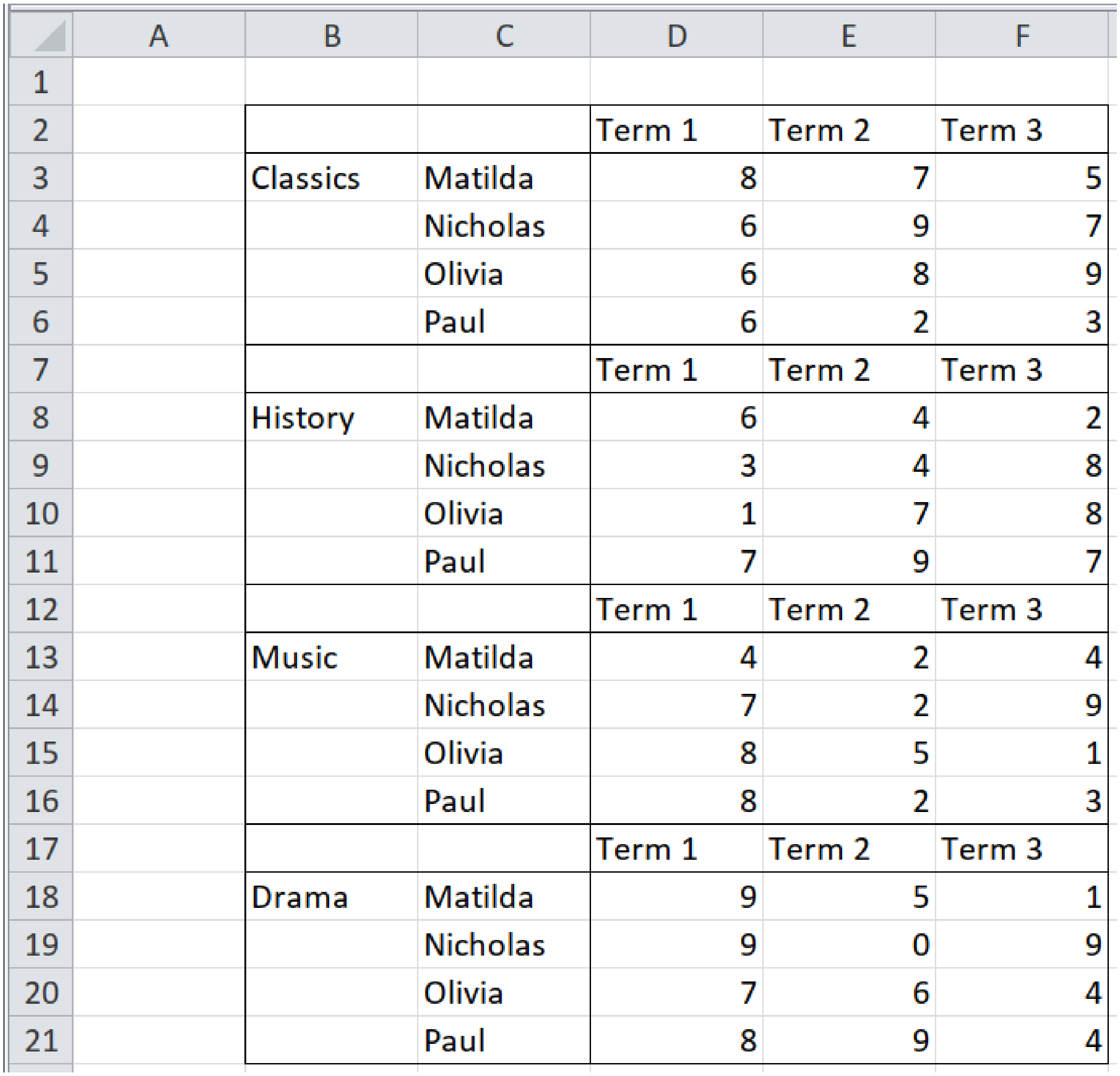
```
name <-
  dplyr::filter(all_cells, row == 2) %>%
  select(row, col, name = character)
  # The title of this header is 'name'.
  # The cells are text cells, so take the value in the '`character` column.
name
```

```
## # 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.

```r
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>            3
##  7     3     5 numeric   <NA>            8
##  8     3     6 numeric   <NA>            8
##  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  3      8      8
##  3         4 <NA>     Nicholas 3      0      7
##  4         5 <NA>     Olivia   0      0      2
##  5         6 <NA>     Paul     2      9      6
##  6         7 <NA>     <NA>     Term 1 Term 2 Term 3
##  7         8 History  Matilda  3      3      9
##  8         9 <NA>     Nicholas 6      9      5
##  9        10 <NA>     Olivia   8      8      6
## 10        11 <NA>     Paul     1      1      5
## 11        12 <NA>     <NA>     Term 1 Term 2 Term 3
## 12        13 Music    Matilda  1      2      2
## 13        14 <NA>     Nicholas 4      3      8
## 14        15 <NA>     Olivia   5      0      0
## 15        16 <NA>     Paul     5      9      5
## 16        17 <NA>     <NA>     Term 1 Term 2 Term 3
## 17        18 Drama    Matilda  7      7      9
## 18        19 <NA>     Nicholas 2      2      2
## 19        20 <NA>     Olivia   2      7      3
## 20        21 <NA>     Paul     8      0      9
```

```
# 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
```

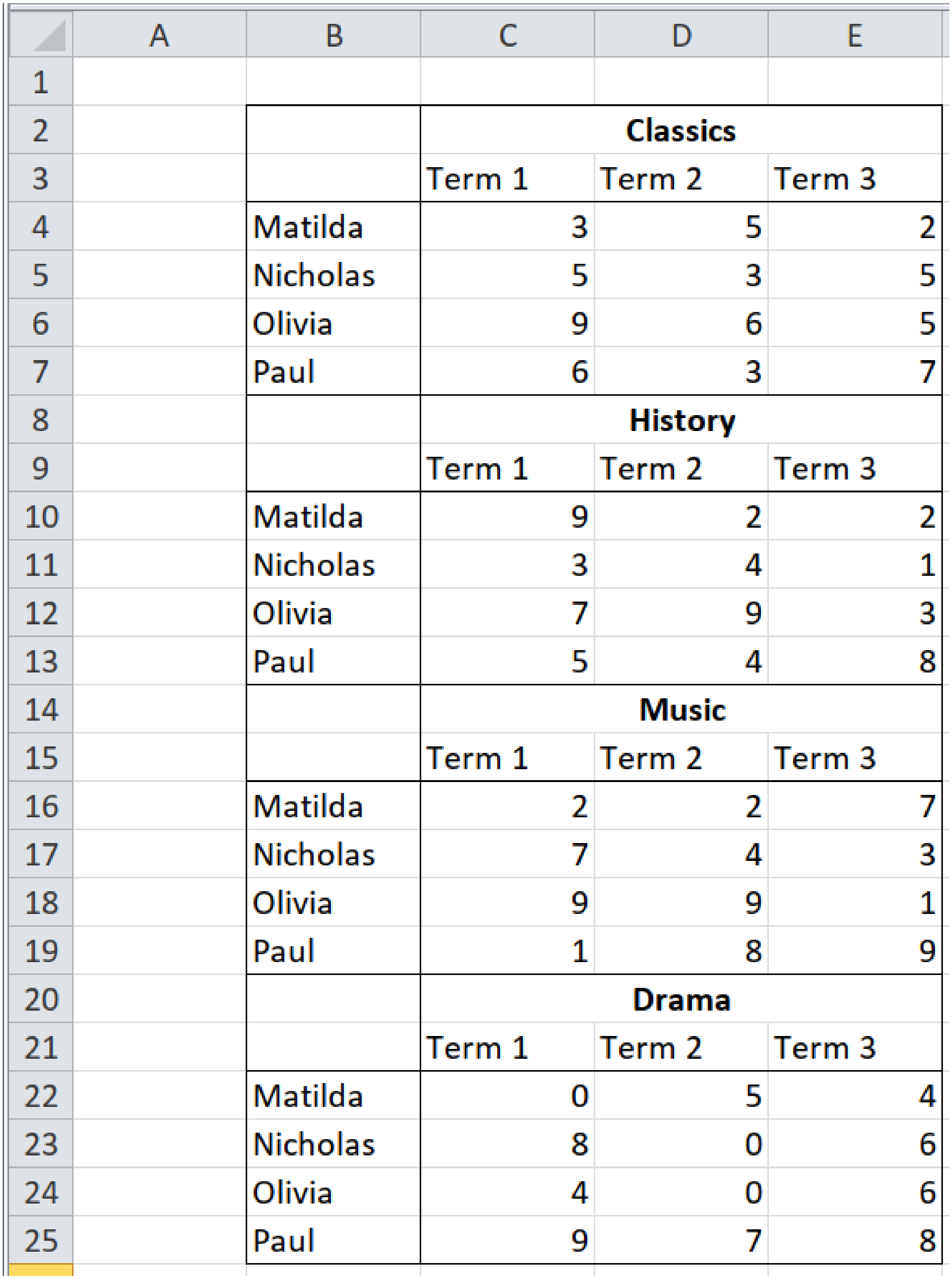
```
# The data cells are distinguished from the 'term' headers by their data type --
# the data cells are numeric, whereas the term headers are character.
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is exam scores in certain subjects, 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     3
##  2     3     5     8
##  3     3     6     8
##  4     4     4     3
##  5     4     5     0
##  6     4     6     7
##  7     5     4     0
##  8     5     5     0
##  9     5     6     2
## 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     3 Term 1 Classics Matilda
##  2     8 Term 2 Classics Matilda
##  3     8 Term 3 Classics Matilda
##  4     3 Term 1 Classics Nicholas
##  5     0 Term 2 Classics Nicholas
##  6     7 Term 3 Classics Nicholas
##  7     0 Term 1 Classics Olivia
##  8     0 Term 2 Classics Olivia
##  9     2 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.

```r
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              50
##  2     3     3 character Term 1         NA              19
##  3     3     4 character Term 2         NA              36
##  4     3     5 character Term 3         NA              20
##  5     4     2 character Matilda        NA              17
##  6     4     3 numeric   <NA>            7              17
##  7     4     4 numeric   <NA>            5              26
##  8     4     5 numeric   <NA>            4              18
##  9     5     2 character Nicholas       NA              19
## 10     5     3 numeric   <NA>            3              19
## # ... with 70 more rows
```

```r
# 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  7        5      4
##  4         5 Nicholas 3        7      4
##  5         6 Olivia   0        1      5
##  6         7 Paul     2        5      4
##  7         8 <NA>     History  <NA>   <NA>
##  8         9 <NA>     Term 1   Term 2 Term 3
##  9        10 Matilda  1        5      6
## 10        11 Nicholas 2        5      4
## # ... with 14 more rows
```

```r
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     7
##  2     4     4     5
##  3     4     5     4
##  4     5     3     3
##  5     5     4     7
##  6     5     5     4
##  7     6     3     0
##  8     6     4     1
##  9     6     5     5
## 10     7     3     2
## # ... 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     7 Classics Term 1 Matilda
##  2     5 Classics Term 2 Matilda
##  3     4 Classics Term 3 Matilda
##  4     3 Classics Term 1 Nicholas
##  5     7 Classics Term 2 Nicholas
##  6     4 Classics Term 3 Nicholas
##  7     0 Classics Term 1 Olivia
##  8     1 Classics Term 2 Olivia
##  9     5 Classics Term 3 Olivia
## 10     2 Classics Term 1 Paul
## # ... with 38 more rows
```

Chapter 4

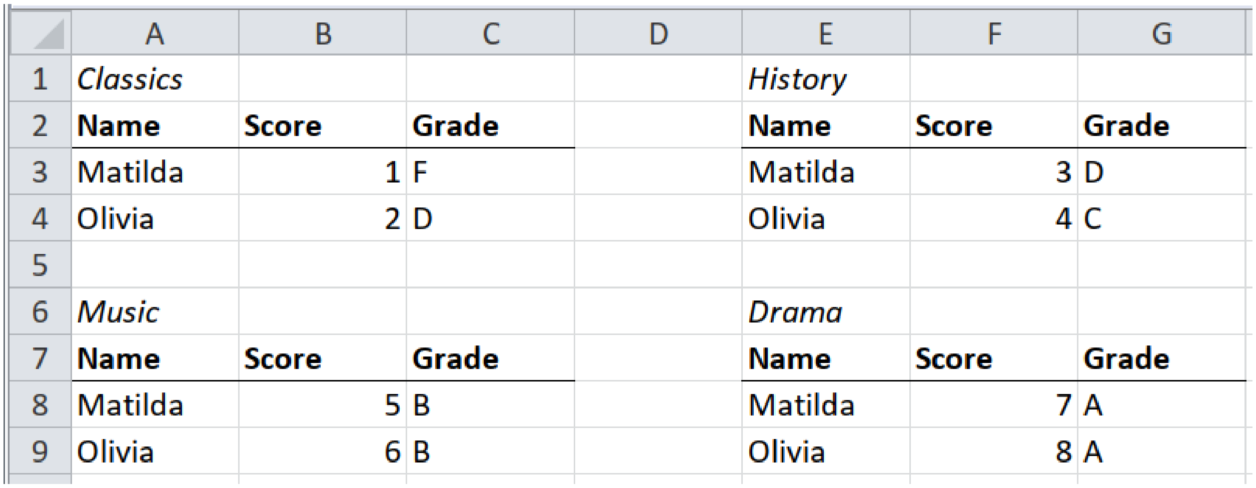
Small multiples

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
```

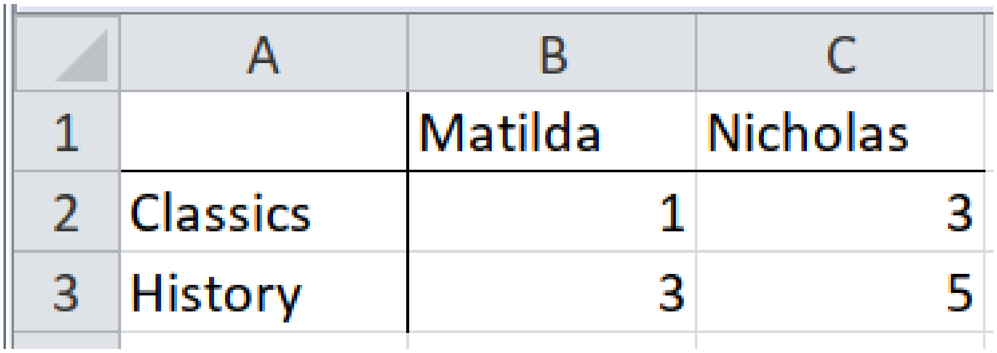
```
## # A tibble: 4 x 3
##   corner_row corner_col cells
##        <dbl>      <dbl> <list>
## 1          1          1 <tibble [10 x 6]>
## 2          1          5 <tibble [10 x 6]>
## 3          6          1 <tibble [10 x 6]>
## 4          6          5 <tibble [10 x 6]>
```

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

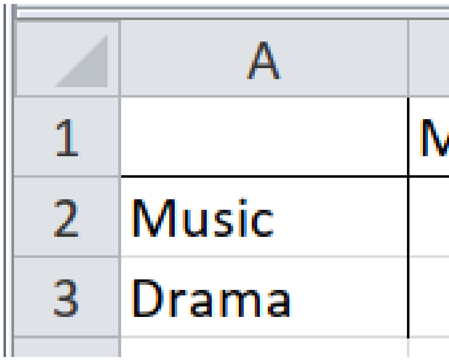
```
partitions %>%
  mutate(cells = map(cells, unpivot)) %>%
  unnest() %>%
  select(-corner_row, -corner_col)
```

```
## # 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		M
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()
```

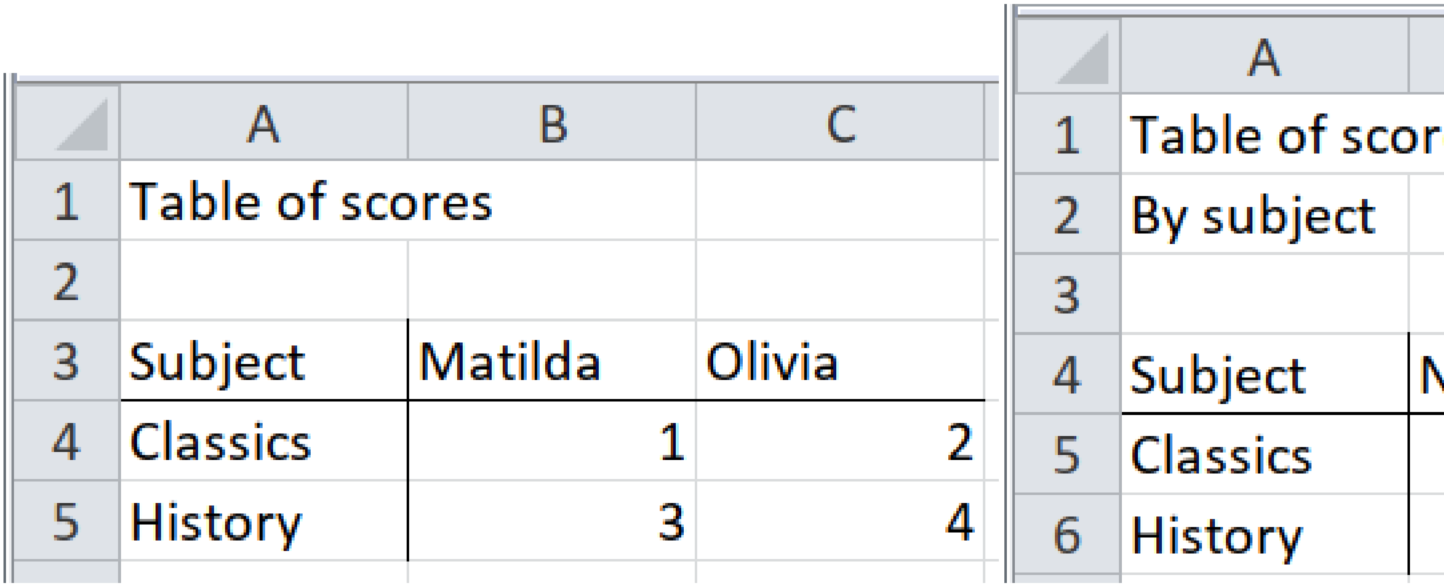
```
## # A tibble: 8 x 8
##   sheet         row   col data_type character numeric name     subject
##   <chr>       <int> <int> <chr>     <chr>       <dbl> <chr>    <chr>
## 1 humanities      2     2 numeric   <NA>            1 Matilda  Classics
## 2 humanities      2     3 numeric   <NA>            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	N
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
```

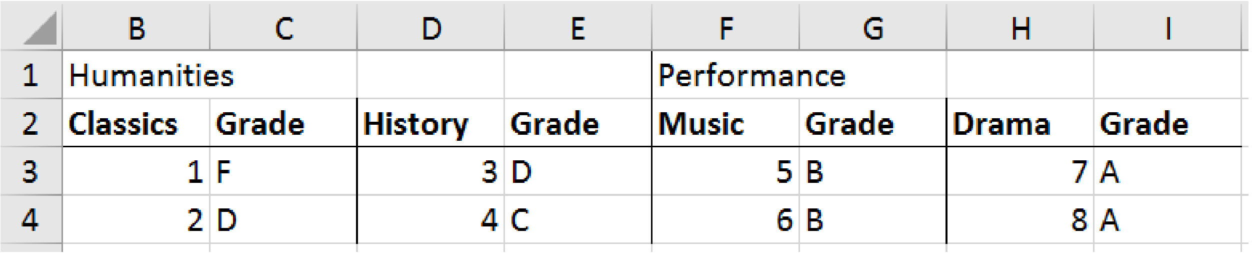
```
## # A tibble: 21 x 6
##    sheet    row   col data_type character       numeric
##    <chr>  <int> <int> <chr>     <chr>             <dbl>
##  1 female     1     1 character Table of scores      NA
##  2 female     3     1 character Subject              NA
##  3 female     3     2 character Matilda              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.



	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.

The process is long-winded, but there are only two new ideas:

1. Unpivot the corner cells on their own, with no data.
2. Rename the corner cells to be normal header cells.

TODO: link to `vaccinations` case study.

```
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)
```

Unpivot only the corner cells "Classics", "History", etc. to associate them with their field ("Humanities", "Performance"), and store them in the variable `corners`. It feels odd to unpivot only the headers and not the data, but bear with it.

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

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

Now the cells "Classics" and "History" can both be renamed "score", which is their function at the head of their columns (rather than labels of the implied small multiples).

```
cells <-
  all_cells %>%
  dplyr::filter(row >= 2, col >= 2) %>%
  mutate(character = if_else(character == "Grade", character, "score"))
```

Use `corners` to partition the rest of the headers and the data cells. Notice that the subject and field are mapped to the appropriate partition.

```
partitions <-
  partition(cells, corners, strict = FALSE) %>%
  # `strict = FALSE` because the corners aren't among the cells
  select(-corner_row, corner_col)
partitions
```

```
## # A tibble: 4 x 4
##   corner_col cells            subject  field
##        <dbl> <list>           <chr>    <chr>
## 1          2 <tibble [6 x 5]> Classics Humanities
## 2          4 <tibble [6 x 5]> History  Humanities
## 3          6 <tibble [6 x 5]> Music    Performance
## 4          8 <tibble [6 x 5]> Drama    Performance
```

Unnest and unpivot the “score” and “grade” headers.

```
partitions <-
  partitions %>%
  unnest() %>%
  behead("N", "header") %>%
  select(-col, -corner_col)
partitions
```

```
## # A tibble: 16 x 7
##    subject  field         row data_type character numeric header
##    <chr>    <chr>       <int> <chr>     <chr>       <dbl> <chr>
##  1 Classics Humanities      3 numeric   <NA>            1 score
##  2 Classics Humanities      3 character score          NA Grade
##  3 Classics Humanities      4 numeric   <NA>            2 score
##  4 Classics Humanities      4 character score          NA Grade
##  5 History  Humanities      3 numeric   <NA>            3 score
##  6 History  Humanities      3 character score          NA Grade
##  7 History  Humanities      4 numeric   <NA>            4 score
##  8 History  Humanities      4 character score          NA Grade
##  9 Music    Performance     3 numeric   <NA>            5 score
## 10 Music    Performance     3 character score          NA Grade
## 11 Music    Performance     4 numeric   <NA>            6 score
## 12 Music    Performance     4 character score          NA Grade
## 13 Drama    Performance     3 numeric   <NA>            7 score
## 14 Drama    Performance     3 character score          NA Grade
## 15 Drama    Performance     4 numeric   <NA>            8 score
## 16 Drama    Performance     4 character score          NA Grade
```

The “Name” row headers can now be joined.

```
name <-
  all_cells %>%
  dplyr::filter(row >= 3, col == 1) %>%
  select(row, name = character)
name
```

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

```
partitions <- inner_join(partitions, name, by = "row")
partitions
```

```
## # A tibble: 16 x 8
##    subject  field         row data_type character numeric header name
##    <chr>    <chr>       <int> <chr>     <chr>       <dbl> <chr>  <chr>
##  1 Classics Humanities      3 numeric   <NA>            1 score  Matilda
##  2 Classics Humanities      3 character score          NA Grade  Matilda
##  3 Classics Humanities      4 numeric   <NA>            2 score  Olivia
##  4 Classics Humanities      4 character score          NA Grade  Olivia
##  5 History  Humanities      3 numeric   <NA>            3 score  Matilda
##  6 History  Humanities      3 character score          NA Grade  Matilda
##  7 History  Humanities      4 numeric   <NA>            4 score  Olivia
##  8 History  Humanities      4 character score          NA Grade  Olivia
##  9 Music    Performance     3 numeric   <NA>            5 score  Matilda
## 10 Music    Performance     3 character score          NA Grade  Matilda
## 11 Music    Performance     4 numeric   <NA>            6 score  Olivia
## 12 Music    Performance     4 character score          NA Grade  Olivia
## 13 Drama    Performance     3 numeric   <NA>            7 score  Matilda
## 14 Drama    Performance     3 character score          NA Grade  Matilda
## 15 Drama    Performance     4 numeric   <NA>            8 score  Olivia
## 16 Drama    Performance     4 character score          NA Grade  Olivia
```

Finally everything can be spattered into a recognisable table.

```
spatter(partitions, header) %>%
  select(-row)
```

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

The process is easier to understand when seen as a whole.

```
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)

name <-
  all_cells %>%
  dplyr::filter(row >= 3, col == 1) %>%
  select(row, name = character)

# Unpivot the corner cells on their own (no data)
corners <-
  all_cells %>%
  dplyr::filter(col >= 2, row <= 2, character != "Grade") %>%
  behead("NNW", "field") %>%
  dplyr::select(row, col, subject = character, field)
```

```r
all_cells %>%
  dplyr::filter(row >= 2, col >= 2) %>%
  # Rename the corner cells as normal header cells
  mutate(character = if_else(character == "Grade", character, "score")) %>%
  # Partition by the corner cells, and bring the subject fields with them
  partition(corners, strict = FALSE, nest = FALSE) %>%
  select(-corner_row, corner_col) %>%
  # Do some normal unpivotring
  behead("N", "header") %>%
  select(-col, -corner_col) %>%
  # Attach the row headers
  inner_join(name, by = "row") %>%
  # Present as a normal table
  spatter(header) %>%
  select(-row)
```

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

Chapter 5

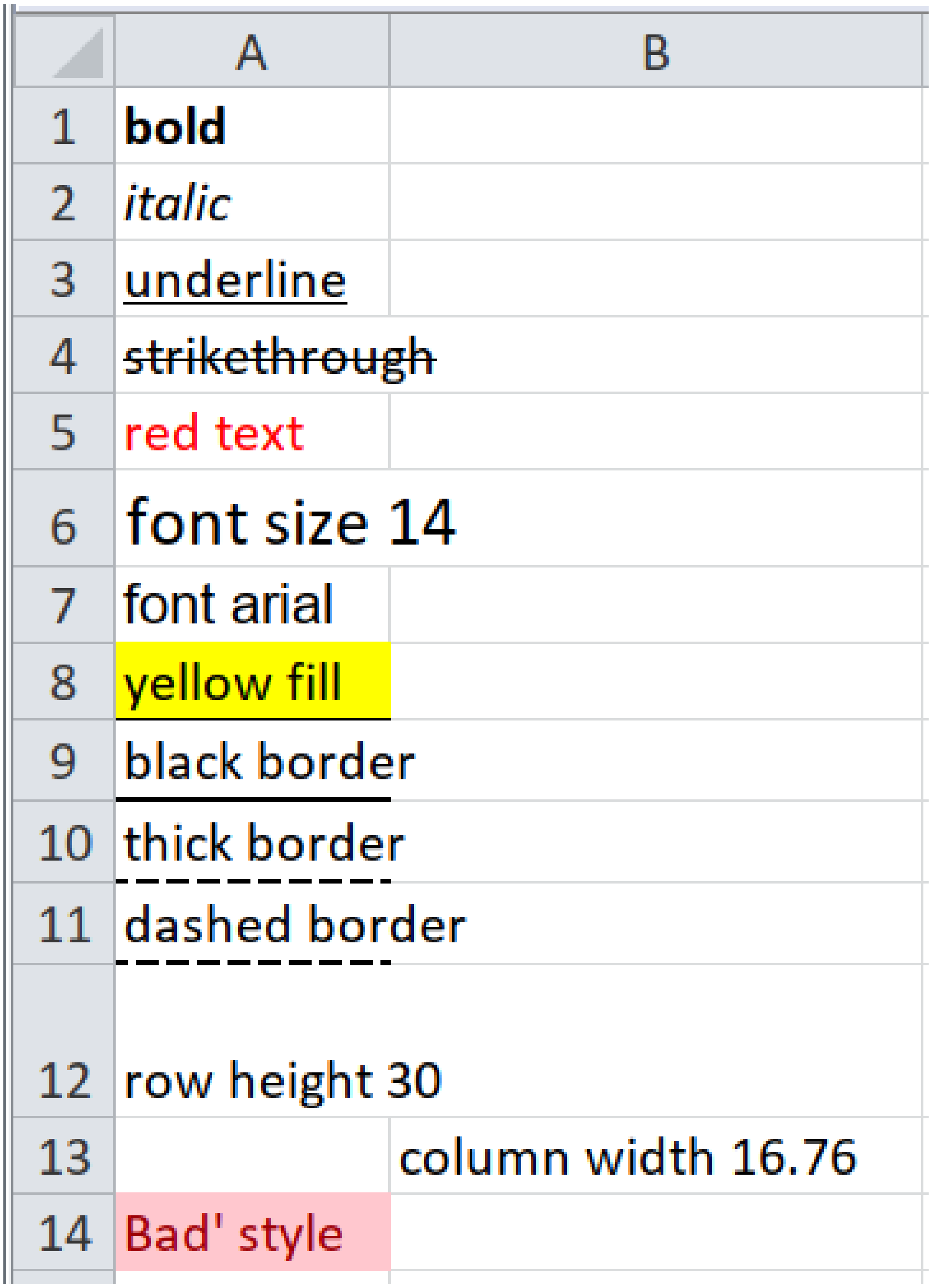
Formatting

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



	A	B
1	**bold**	
2	*italic*	
3	underline	
4	~~strikethrough~~	
5	red text	
6	font size 14	
7	font arial	
8	yellow fill	
9	black border	
10	thick border	
11	dashed border	
12	row height 30	
13		column width 16.76
14	Bad' style	

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

```r
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                           5
##  2     2     1 italic             Normal                           7
##  3     3     1 underline          Normal                          54
##  4     4     1 strikethrough      Normal                          55
##  5     5     1 red text           Normal                          11
##  6     6     1 font size 14       Normal                          56
##  7     7     1 font arial         Normal                          57
##  8     8     1 yellow fill        Normal                          10
##  9     9     1 black border       Normal                          42
## 10    10     1 thick border       Normal                          58
## 11    11     1 dashed border      Normal                          59
## 12    12     1 row height 30      Normal                           1
## 13    13     2 column width 16.76 Normal                           1
## 14    14     1 Bad' style         Excel Built-in Bad              60
```

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

```
##   [1] FALSE  TRUE FALSE FALSE  TRUE  TRUE FALSE FALSE FALSE FALSE FALSE
##  [12] FALSE FALSE  TRUE FALSE  TRUE FALSE 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  TRUE FALSE  TRUE FALSE FALSE FALSE
##  [56] FALSE FALSE FALSE FALSE FALSE FALSE
```

```
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                           5 TRUE
##  2     2     1 italic             Normal                           7 FALSE
##  3     3     1 underline          Normal                          54 FALSE
##  4     4     1 strikethrough      Normal                          55 FALSE
##  5     5     1 red text           Normal                          11 FALSE
##  6     6     1 font size 14       Normal                          56 FALSE
##  7     7     1 font arial         Normal                          57 FALSE
##  8     8     1 yellow fill        Normal                          10 FALSE
##  9     9     1 black border       Normal                          42 FALSE
## 10    10     1 thick border       Normal                          58 FALSE
## 11    11     1 dashed border      Normal                          59 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         Excel Built-in Bad              60 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 [1:61] "General" "General" "General" "General" ...
##   ..$ font      :List of 10
##   .. ..$ bold     : logi [1:61] FALSE TRUE FALSE FALSE TRUE TRUE ...
##   .. ..$ italic   : logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ underline: chr [1:61] NA NA NA NA ...
##   .. ..$ strike   : logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ vertAlign: chr [1:61] NA NA NA NA ...
##   .. ..$ size     : num [1:61] 11 11 11 11 11 11 11 11 11 11 ...
##   .. ..$ color    :List of 4
##   .. .. ..$ rgb    : chr [1:61] "FF000000" "FF000000" "FF000000" NA ...
##   .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ name     : chr [1:61] "Calibri" "Calibri" "Calibri" "Calibri" ...
##   .. ..$ family   : int [1:61] 2 2 2 2 2 2 2 2 2 2 ...
##   .. ..$ scheme   : chr [1:61] NA NA NA NA ...
##   ..$ fill      :List of 2
##   .. ..$ patternFill :List of 3
##   .. .. ..$ fgColor    :List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ bgColor    :List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ patternType: chr [1:61] NA NA NA NA ...
##   .. ..$ gradientFill:List of 8
##   .. .. ..$ type  : chr [1:61] NA NA NA NA ...
##   .. .. ..$ degree: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ left  : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ right : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ top   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ bottom: num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ stop1 :List of 2
##   .. .. .. ..$ position: num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. ..$ stop2 :List of 2
##   .. .. .. ..$ position: num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   ..$ border    :List of 12
##   .. ..$ diagonalDown: logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ diagonalUp  : logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ outline     : logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ left        :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ right       :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ start       :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ end         :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ top         :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ bottom      :List of 2
##   .. .. ..$ style: chr [1:61] NA "thin" NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ diagonal    :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ vertical    :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. ..$ horizontal  :List of 2
##   .. .. ..$ style: chr [1:61] NA NA NA NA ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ theme  : chr [1:61] NA NA NA NA ...
##   .. .. .. ..$ indexed: int [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..$ tint   : num [1:61] NA NA NA NA NA NA NA NA NA NA ...
##   ..$ alignment :List of 8
##   .. ..$ horizontal     : chr [1:61] "general" "general" "general" "general" ...
##   .. ..$ vertical       : chr [1:61] "bottom" "bottom" "bottom" "bottom" ...
##   .. ..$ wrapText       : logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ readingOrder   : chr [1:61] "context" "context" "context" "context" ...
##   .. ..$ indent         : int [1:61] 0 0 0 0 0 0 0 0 0 0 ...
##   .. ..$ justifyLastLine: logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ shrinkToFit    : logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. ..$ textRotation   : int [1:61] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ protection:List of 2
##   .. ..$ locked: logi [1:61] TRUE TRUE TRUE TRUE TRUE TRUE ...
##   .. ..$ hidden: logi [1:61] FALSE FALSE FALSE FALSE FALSE FALSE ...
##  $ style:List of 6
##   ..$ numFmt    : Named chr [1:22] "General" "General" "General" "General" ...
##   .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   ..$ font      :List of 10
##   .. ..$ bold     : Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ italic   : Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ underline: Named chr [1:22] NA NA NA NA ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ strike   : Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ vertAlign: Named chr [1:22] NA NA NA NA ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ size     : Named num [1:22] 11 10 10 10 10 11 11 11 11 11 ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ color    :List of 4
##   .. .. ..$ rgb    : Named chr [1:22] "FF000000" NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ name     : Named chr [1:22] "Calibri" "Arial" "Arial" "Arial" ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ family   : Named int [1:22] 2 0 0 0 0 2 2 2 2 2 ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ scheme   : Named chr [1:22] NA NA NA NA ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   ..$ fill      :List of 2
##   .. ..$ patternFill :List of 3
##   .. .. ..$ fgColor    :List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ bgColor    :List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ patternType: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ gradientFill:List of 8
##   .. .. ..$ type  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ degree: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ left  : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ right : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ top   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ bottom: Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ stop1 :List of 2
##   .. .. .. ..$ position: Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ stop2 :List of 2
##   .. .. .. ..$ position: Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ color   :List of 4
##   .. .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   ..$ border    :List of 12
##   .. ..$ diagonalDown: Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ diagonalUp  : Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ outline     : Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ left        :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ right       :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ start       :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ end         :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ top         :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ bottom      :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ diagonal    :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ vertical    :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ horizontal  :List of 2
##   .. .. ..$ style: Named chr [1:22] NA NA NA NA ...
##   .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. ..$ color:List of 4
##   .. .. .. ..$ rgb    : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ theme  : Named chr [1:22] NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ indexed: Named int [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. .. .. ..$ tint   : Named num [1:22] NA NA NA NA NA NA NA NA NA NA ...
##   .. .. .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   ..$ alignment :List of 8
##   .. ..$ horizontal     : Named chr [1:22] "general" "general" "general" "general" ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ vertical       : Named chr [1:22] "bottom" "bottom" "bottom" "bottom" ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ wrapText       : Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ readingOrder   : Named chr [1:22] "context" "context" "context" "context" ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ indent         : Named int [1:22] 0 0 0 0 0 0 0 0 0 0 ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ justifyLastLine: Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ shrinkToFit    : Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ textRotation   : Named int [1:22] 0 0 0 0 0 0 0 0 0 0 ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   ..$ protection:List of 2
##   .. ..$ locked: Named logi [1:22] TRUE TRUE TRUE TRUE TRUE TRUE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
##   .. ..$ hidden: Named logi [1:22] FALSE FALSE FALSE FALSE FALSE FALSE ...
##   .. .. ..- attr(*, "names")= chr [1:22] "Normal" "Comma" "Comma [0]" "Currency" ...
```

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                     5
```

```
formats <- xlsx_formats(path)

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

```
##  [1] FALSE  TRUE FALSE FALSE  TRUE  TRUE FALSE FALSE FALSE FALSE FALSE
## [12] FALSE FALSE  TRUE FALSE  TRUE FALSE 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  TRUE FALSE  TRUE FALSE FALSE FALSE
## [56] FALSE FALSE FALSE FALSE FALSE FALSE
```

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

```
##              Normal               Comma           Comma [0]
##               FALSE               FALSE               FALSE
##            Currency        Currency [0]             Percent
##               FALSE               FALSE               FALSE
##            Normal 2 Excel Built-in Bad                <NA>
##               FALSE               FALSE               FALSE
##                <NA>                <NA>                <NA>
##               FALSE               FALSE               FALSE
##                <NA>                <NA>                <NA>
##               FALSE               FALSE               FALSE
##                <NA>                <NA>                <NA>
##               FALSE               FALSE               FALSE
##                <NA>                <NA>                <NA>
##               FALSE               FALSE               FALSE
##                <NA>
##               FALSE
```

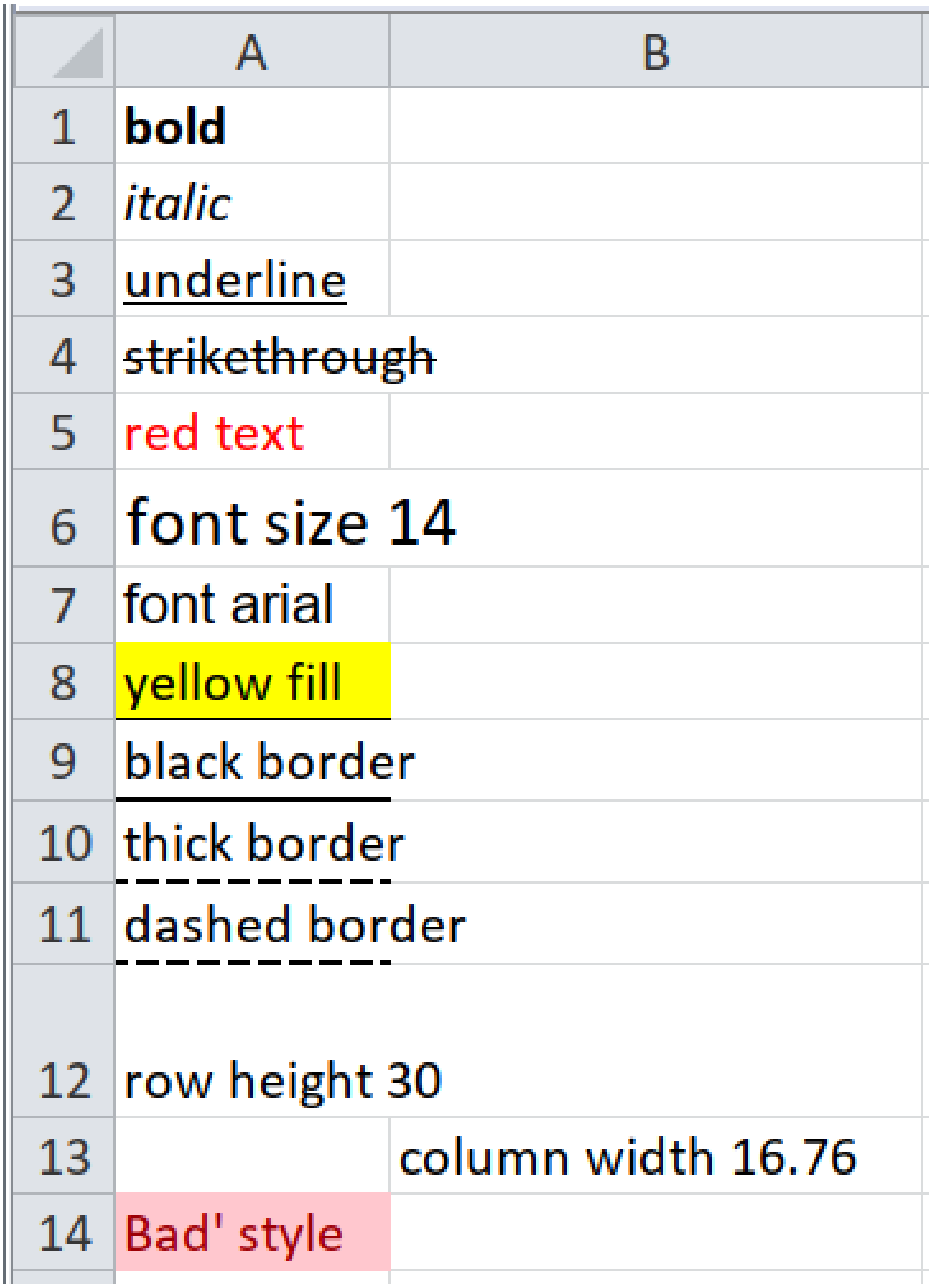
```
mutate(cells,
       style_bold = style_bold[style_format],
       local_bold = local_bold[local_format_id])
```

```
## # 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                     5 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



	A	B
1	**bold**	
2	*italic*	
3	underline	
4	~~strikethrough~~	
5	red text	
6	font size 14	
7	font arial	
8	yellow fill	
9	black border	
10	thick border	
11	dashed border	
12	row height 30	
13		column width 16.76
14	Bad' style	

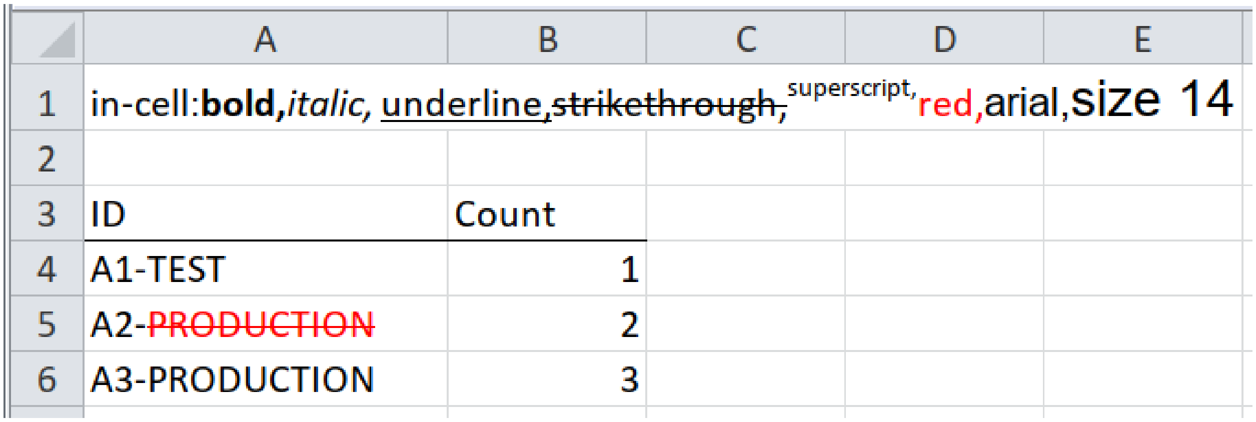
This example shows how to look up the most common formats.

```
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                     5   15    8.67 TRUE
##  2     2     1 italic      Normal                     7   15    8.67 FALSE
##  3     3     1 underline   Normal                    54   15    8.67 FALSE
##  4     4     1 strikethro~ Normal                    55   15    8.67 FALSE
##  5     5     1 red text    Normal                    11   15    8.67 FALSE
##  6     6     1 font size ~ Normal                    56   18.8  8.67 FALSE
##  7     7     1 font arial  Normal                    57   15    8.67 FALSE
##  8     8     1 yellow fill Normal                    10   15    8.67 FALSE
##  9     9     1 black bord~ Normal                    42   15.8  8.67 FALSE
## 10    10     1 thick bord~ Normal                    58   15.8  8.67 FALSE
## 11    11     1 dashed bor~ Normal                    59   15.8  8.67 FALSE
## 12    12     1 row height~ Normal                     1   30    8.67 FALSE
## 13    13     2 column wid~ Normal                     1   15   17.4  FALSE
## 14    14     1 Bad' style  Excel Built~              60   15    8.67 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>
```

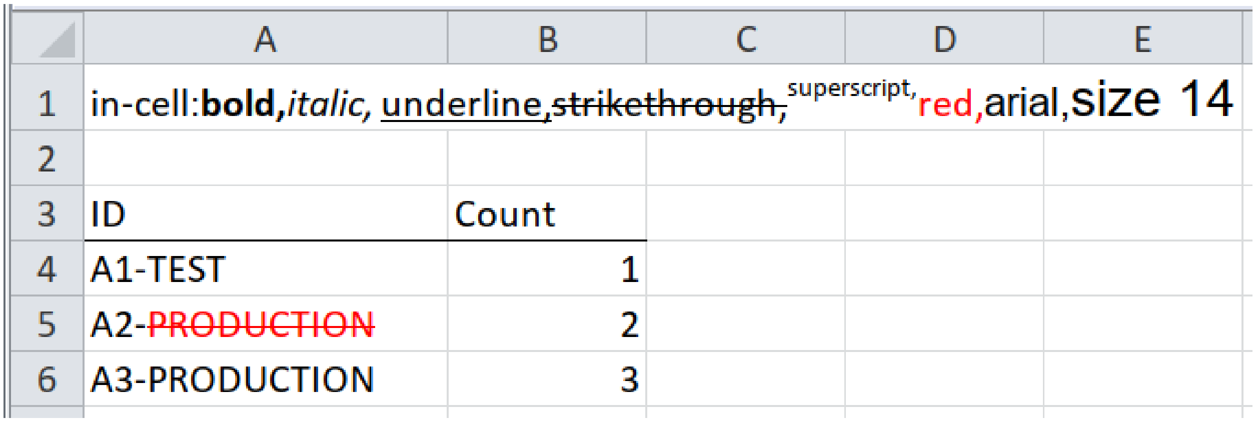
The way to access these data frames is via `tidyr::unnest()`. In this example, a single cell has a long string of words, where each word is formatted differently.

```
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.

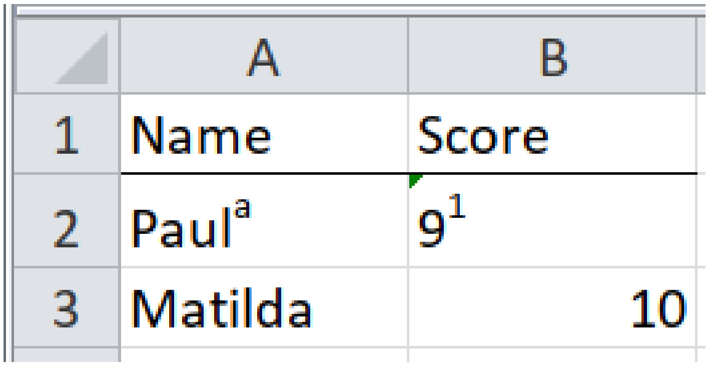
```
strikethrough <-
  xlsx_cells(path, sheet = "in-cell formatting") %>%
  dplyr::filter(address != "A1", col == 1) %>%
  mutate(strikethrough = map_lgl(character_formatted, ~ any(.x$strike))) %>%
  select(row, col, character, strikethrough)
```

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?

```r
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.

```r
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.

```r
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

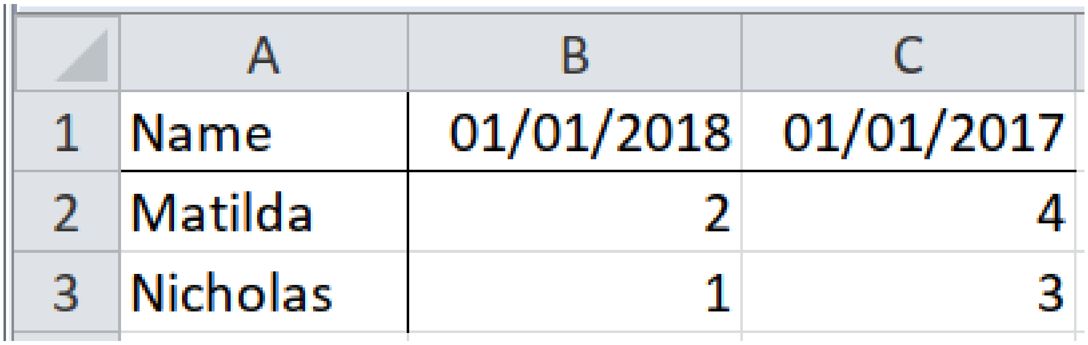
TODO: rework the vignette?

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.

```r
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()`.

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

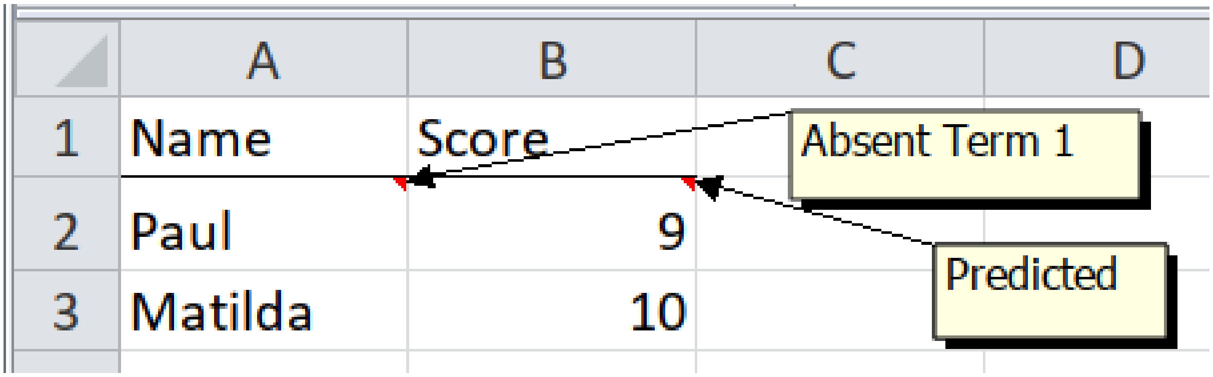
```
## # A tibble: 6 x 7
##     row   col data_type character numeric date                header
##   <int> <int> <chr>     <chr>       <dbl> <dttm>              <chr>
## 1     2     1 character Matilda        NA NA                  Name
## 2     2     2 numeric   <NA>            2 NA                  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()`.

```r
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



	A	B	C	D
1	Name	Score		
2	Paul	9		
3	Matilda	10		

Absent Term 1

Predicted

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`.

```r
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