

# Spreadsheet Munging Strategies

*Duncan Garmonsway*



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# 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.

---

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Figure 1: Creative Commons License



# Chapter 1

## Setup

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

### 1.1 Packages

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

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

##
## Attaching package: 'dplyr'

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

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

library(purrr)
library(stringr)
library(readr)
library(readxl)
library(tidyxl)
library(unpivotr)
library(smungs)
```

### 1.2 Data

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

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





## Chapter 2

# Tidy-ish tables

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

### 2.1 Clean & tidy tables

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

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

Clean and tidy means

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

Here's the full process.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## 2.2 Almost-tidy tables

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

For everything else, read on.

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

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

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

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

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

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

Tidymodels and unpivotr are agnostic to the layout of tables. Importing the transpose is the same as 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	<b>Title text</b>			
2				
3		<b>Name</b>	<b>Age</b>	
4		Matilda	1	
5		Nicholas	3	
6				
7				<i>Footnote</i>

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 palette 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` palette.
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 FFFFFFF00
## 3     5     6 <NA>

```

Note that the fill colour is expressed as an RGB value with transparency in the first two letters, e.g. FFFFFFF00 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 FFFFFFF00    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 palette 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` palette.
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 FFFFFFF0 <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 FFFFFFF0 <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 FFFFFFF0
## 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 palette 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' palette.
```

```
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 FFFFFFF00
## 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 FFFFFFF00
## 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 FFFFFFF00 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	<b>Name</b>	<b>Weight</b>	<b>Price</b>
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 palette of fill colours that can be indexed by the
```

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

# Import all the cells, filter out the header row, filter for the first column,
# and create a new column `fill` of the fill colours, by looking up the
# local_format_id of each cell in the `formats` palette.
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 FFFFFFF00  FF000000
## 3 Spoon         3     4 <NA>      FFFF0000
## 4 Teaspoon      1     2 FFFFFFF00  FFFF0000
```

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

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

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

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

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

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

```
## # A tibble: 4 x 6
##   data_type Name      Price Weight fill_colour font_colour
##   <chr>      <chr>    <dbl>  <dbl> <chr>      <chr>
## 1 numeric  Knife         8      7 <NA>      FF000000
## 2 numeric  Fork          6      5 FFFFFFF00 <NA>
## 3 numeric  Spoon         4      3 <NA>      FFFF0000
```

```
## 4 numeric    Teaspoon      2      1 FFFFFFF00    FFFF0000
```

## 2.6 Hierarchies in formatting

	A	B
1	Name	Score
2	Matilda	7
3	<i>Nicholas</i>	5
4	<b>Olivia</b>	3
5	<b><i>Paul</i></b>	1

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

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

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

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

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

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

```
# `formats` is a palette 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` palette.
```

```
formats <-
  xlsx_cells(path, sheet = "highlight-hierarchy") %>%
  dplyr::filter(row >= 2, col == 1) %>% # Omit the header row
  mutate(bold = bold[local_format_id],
         italic = italic[local_format_id]) %>%
  mutate(grade = case_when(bold & italic ~ "fail",
                           bold ~ "poor",
                           italic ~ "satisfactory",
                           TRUE ~ "good")) %>%
  select(bold, italic, grade)
```

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

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

Here it is again, using only tidyxl and unpivotr.

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

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

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



## 2.7 Sentinel values in non-text columns

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

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

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

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

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

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

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

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

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

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

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

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

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

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

```
# Extra-tidy, with row and column numbers of the original variables, and the
# sentinels omitted
```

```
extra_tidy <-
  read_excel(path, sheet = "sentinels", na = c("NA", "...", "..C")) %>%
  mutate(row = row_number() + 1L) %>%
  gather(variable, value, -row, -Name) %>%
  group_by(row) %>%
  mutate(col = row_number() + 1L) %>%
  ungroup() %>%
  select(row, col, Name, variable, value) %>%
  arrange(row, col)
extra_tidy
```

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

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

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

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

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

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

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

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

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



## Chapter 3

# Pivot tables

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

### 3.1 Simple unpivoting

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

	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		Performance	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 meaningfully formatted cells doesn't work here, because the unpivoting of multiple rows/columns of headers complicates the relationship between the data and the formatting.

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

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

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

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

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

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

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

```
## [1] NA      NA      NA      NA      NA      NA
## [7] NA      NA      "FFFFFF00" "FF92D050" "FFFFFF00" NA
## [13] NA      "FFFFFF00" NA      NA      NA      NA
## [19] NA      NA      NA      "FFFFFF00" "FFFFFF00" NA
## [25] NA      "FFFFFF00" NA      NA      NA      NA
## [31] NA      NA      NA      NA      NA      NA
## [37] NA      NA      NA      NA      NA      NA
## [43] NA      NA      NA      NA      NA      NA
## [49] NA      NA      NA      NA      NA      NA
## [55] NA      NA      "FFFC7CE" NA      NA
```

```
# Import all the cells, filter out the header row, filter for the first column,
# and create a new column `approximate` based on the fill colours, by looking up
# the local_format_id of each cell in the `formats` palette.
```

```
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 FFFFFFF00
## 3     4     6 <NA>
## 4     4     7 <NA>
## 5     5     4 FFFFFFF00
## 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 FFFFFFF00
## 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 FFFFFFF00
## 3 numeric      3 Female Matilda Humanities History FFFFFFF00
## 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 FFFFFFF00
## 16 numeric     3 Male  Paul Performance Drama <NA>
```

## 3.2 Complex unpivoting

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

This kind of unpivoting is always done in two stages.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is 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(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		Performance	Music	5	6	9	2
7			Drama	7	8	12	3

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

```
data_cells <-
  dplyr::filter(all_cells, data_type == "numeric") %>%
  select(row, col, score = numeric)
  # The data is 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(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 1 Female Matilda Humanities Classics
## 2     2 2 Female Olivia Humanities Classics
## 3     3 3 Female Matilda Humanities History
## 4     4 4 Female Olivia Humanities History
## 5     3 3 Male Nicholas Humanities Classics
## 6     0 0 Male Paul Humanities Classics
## 7     5 5 Male Nicholas Humanities History
## 8     1 1 Male Paul Humanities History
## 9     5 5 Female Matilda Performance Music
## 10    6 6 Female Olivia Performance Music
## 11    7 7 Female Matilda Performance Drama
## 12    8 8 Female Olivia Performance Drama
## 13    9 9 Male Nicholas Performance Music
## 14    2 2 Male Paul Performance Music
## 15   12 12 Male Nicholas Performance Drama
## 16    3 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		Performance	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    Matilda 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 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(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 delete the `row` and `col` columns yet, because we need them to join on
# the formatting

# `formats` is a palette 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` palette.
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 FFFFFFF00
## 3     4     6 <NA>
## 4     4     7 <NA>
## 5     5     4 FFFFFFF00
## 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 FFFFFFF00
## 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 FFFFFFF00
## 3     3 Female Matilda Humanities History  FFFFFFF00
## 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   FFFFFFF00
## 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	<i>0 = absent</i>
3				Matilda	Olivia	Nicholas	Paul
4		Humanities	Classics	1	2	3	0
5		Excl. project work	History	3	4	5	1
6		Performance	Music	5	6	9	2
7		Incl. written exam	Drama	7	8	12	3

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

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

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

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

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

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

```
# Or we can find out what that code is by starting from a cell that we know is
# red.
```

```
red_cell_format_id <-
  xlsx_cells(path, sheets = "pivot-notes") %>%
  dplyr::filter(row == 5, col == 2) %>%
  pull(local_format_id)
red_cell_format_id
```

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

```
indent0
```

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

```
indent1
```

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

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

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

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

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

```
field
```

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

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

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

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

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

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

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

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

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

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

### 3.2.8 Repeated rows/columns of headers within the table

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

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

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

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

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

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

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

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

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

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

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

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

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

```
# The data cells are distinguished from the 'term' headers by their data type --
# the data cells are numeric, whereas the term headers are character.
```

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

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

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

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

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



## 3.2.9 Headers amongst the data

	A	B	C	D	E
1					
2			<b>Classics</b>		
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			<b>History</b>		
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			<b>Music</b>		
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			<b>Drama</b>		
21			Term 1	Term 2	Term 3
22		Matilda	0	5	4
23		Nicholas	8	0	6
24		Olivia	4	0	6
25		Paul	9	7	8



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

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

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

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

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

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

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

```
# The subject headers, though mixed with the data and the 'term' headers, are
# distinguishable by the data type "character" and by being bold.
```

```
subject <-
  dplyr::filter(all_cells,
    col == 3,
    data_type == "character",
    local_format_id %in% bold) %>%
  select(row, col, subject = character)
```

```

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

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

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

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

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

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

```

```

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

```

```

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

```

```

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

```

```

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

```



## Chapter 4

# Small multiples

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

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

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

### 4.1 Small multiples with all headers present for each multiple

	A	B	C	D	E	F	G
1	<i>Classics</i>				<i>History</i>		
2	<b>Name</b>	<b>Score</b>	<b>Grade</b>		<b>Name</b>	<b>Score</b>	<b>Grade</b>
3	Matilda	1	F		Matilda	3	D
4	Olivia	2	D		Olivia	4	C
5							
6	<i>Music</i>				<i>Drama</i>		
7	<b>Name</b>	<b>Score</b>	<b>Grade</b>		<b>Name</b>	<b>Score</b>	<b>Grade</b>
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)
```

```

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 unpivoting
  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	<b>bold</b>	
2	<i>italic</i>	
3	<u>underline</u>	
4	<del>strikethrough</del>	
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.

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

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



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

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

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

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

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

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

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

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

```

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

```

```

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

```

```

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

```

```

## .. .. ..$ rgb      : Named chr [1:2] NA "FFFC7CE"
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ theme    : Named chr [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ indexed: Named int [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ tint     : Named num [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ bgColor  :List of 4
## .. .. ..$ rgb      : Named chr [1:2] NA "FFCCCCFF"
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ theme    : Named chr [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ indexed: Named int [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ tint     : Named num [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ patternType: Named chr [1:2] NA "solid"
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. ..$ gradientFill:List of 8
## .. .. ..$ type     : Named chr [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ degree: Named int [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ left    : Named num [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ right   : Named num [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ top     : Named num [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ bottom: Named num [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ stop1  :List of 2
## .. .. .. ..$ position: Named num [1:2] NA NA
## .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ color   :List of 4
## .. .. .. ..$ rgb    : Named chr [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. .. ..$ theme  : Named chr [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. .. ..$ indexed: Named int [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. .. ..$ tint   : Named num [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ stop2  :List of 2
## .. .. .. ..$ position: Named num [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. ..$ color   :List of 4
## .. .. .. ..$ rgb    : Named chr [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. .. ..$ theme  : Named chr [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"
## .. .. .. ..$ indexed: Named int [1:2] NA NA
## .. .. .. .. ..- attr(*, "names")= chr [1:2] "Normal" "Explanatory Text"

```

```

## ..$ tint : Named num [1:2] NA NA
## ..$ border :List of 12
## ..$ diagonalDown: Named logi [1:2] FALSE FALSE
## ..$ diagonalUp : Named logi [1:2] FALSE FALSE
## ..$ outline : Named logi [1:2] FALSE FALSE
## ..$ left :List of 2
## ..$ style: Named chr [1:2] NA NA
## ..$ color:List of 4
## ..$ rgb : Named chr [1:2] NA NA
## ..$ theme : Named chr [1:2] NA NA
## ..$ indexed: Named int [1:2] NA NA
## ..$ tint : Named num [1:2] NA NA
## ..$ right :List of 2
## ..$ style: Named chr [1:2] NA NA
## ..$ color:List of 4
## ..$ rgb : Named chr [1:2] NA NA
## ..$ theme : Named chr [1:2] NA NA
## ..$ indexed: Named int [1:2] NA NA
## ..$ tint : Named num [1:2] NA NA
## ..$ start :List of 2
## ..$ style: Named chr [1:2] NA NA
## ..$ color:List of 4
## ..$ rgb : Named chr [1:2] NA NA
## ..$ theme : Named chr [1:2] NA NA
## ..$ indexed: Named int [1:2] NA NA
## ..$ tint : Named num [1:2] NA NA
## ..$ end :List of 2
## ..$ style: Named chr [1:2] NA NA
## ..$ color:List of 4
## ..$ rgb : Named chr [1:2] NA NA
## ..$ theme : Named chr [1:2] NA NA
## ..$ indexed: Named int [1:2] NA NA

```

```

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

```

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

## 5.2 Common formats

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

```

### 5.3 In-cell formatting

	A	B	C	D	E
1	in-cell: <b>bold</b> , <i>italic</i> , <u>underline</u> , <del>strikethrough</del> , <sup>superscript</sup> , <b>red</b> ,arial,size 14				
2					
3	ID	Count			
4	A1-TEST	1			
5	A2- <b>PRODUCTION</b>	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: <b>bold</b> , <i>italic</i> , <u>underline</u> , <del>strikethrough</del> , <sup>superscript</sup> , <b>red</b> ,arial,size 14				
2					
3	ID	Count			
4	A1-TEST	1			
5	A2- <b>PRODUCTION</b>	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 <sup>a</sup>	9 <sup>1</sup>
3	Matilda	10

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

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

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

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

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

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

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

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

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

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

```

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

```

```

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

```

```

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

```



## Chapter 6

# Data validation

TODO: rework the vignette?



## Chapter 7

# Formulas

TODO: rework the vignette?



## Chapter 8

# Other gotchas

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

### 8.1 Non-text headers e.g. dates

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

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

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

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

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

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

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

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

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

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

```
## # A tibble: 6 x 7
##   row  col data_type character numeric date      header
##   <int> <int> <chr>      <chr>      <dbl> <dtm>    <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	Absent Term 1	Predicted
2	Paul	9		
3	Matilda	10		

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

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

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

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

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

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

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

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

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

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

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

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

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

### 8.3 Named ranges

TODO



# Chapter 9

## Case studies

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

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


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


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

### 9.1 Australian Marriage Survey

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

There are two tables with structures that are similar but different.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	 <b>Australian Bureau of Statistics</b>															
2	<b>1800.0 Australian Marriage Law Postal Survey, 2017</b>															
3	Released on 15 November 2017															
4	<b>Table 1 Response by State and Territory</b>															
5	Response clear								Eligible Participants							
6	Yes		No		Total		Response clear		Response not clear(a)		Non-responding		Total			
7	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
8	New South Wales	2,374,362	57.8	1,736,838	42.2	4,111,200	100	4,111,200	79.2	11,036	0.2	1,065,445	20.5	5,187,681	100	
9	Victoria	2,145,629	64.9	1,161,098	35.1	3,306,727	100	3,306,727	81.4	11,028	0.3	743,634	18.3	4,081,389	100	
10	Queensland	1,487,060	60.7	961,015	39.3	2,448,075	100	2,448,075	77.7	7,088	0.2	695,710	22.1	3,150,873	100	
11	South Australia	592,528	62.5	356,247	37.5	948,775	100	948,775	79.5	2,778	0.2	242,027	20.3	1,193,580	100	
12	Western Australia	801,575	63.7	455,924	36.3	1,257,499	100	1,257,499	78.3	3,188	0.2	346,333	21.6	1,607,020	100	
13	Tasmania	191,948	63.6	109,655	36.4	301,603	100	301,603	79.5	805	0.2	77,020	20.3	379,428	100	
14	Northern Territory(b)	48,686	60.6	31,690	39.4	80,376	100	80,376	58.2	229	0.2	57,496	41.6	138,101	100	
15	Australian Capital Territory(c)	175,459	74.0	61,520	26.0	236,979	100	236,979	82.3	534	0.2	50,595	17.6	288,108	100	
16	<b>Australia</b>	<b>7,817,247</b>	<b>61.6</b>	<b>4,873,987</b>	<b>38.4</b>	<b>12,691,234</b>	<b>100</b>	<b>12,691,234</b>	<b>79.3</b>	<b>36,686</b>	<b>0.2</b>	<b>3,278,260</b>	<b>20.5</b>	<b>16,006,180</b>	<b>100</b>	
17																
18	(a) Includes blank responses															
19	(b) Includes Christmas Island and the Cocos (Keeling) Islands (within the Division of Lingian)															
20	(c) Includes Jervis Bay (within the Division of Fenner) and Norfolk Island (within the Division of Canberra)															
21																
22	© Commonwealth of Australia 2017															



**Miles McBain**  
 @MilesMcBain

Following

I just published “Tidying the Australian Same Sex Marriage Postal Survey Data with R”

Released on 15 November 2017

**Table 5 Participation by Federal Electoral Division(a), Males and Age Gender apartheid**

	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years
<b>Yeah NA</b>										
Unlabeled	292	1,058	1,465	1,653	1,515	1,516	1,710	1,730	1,753	1,574
Eligible participants	512	2,910	3,789	3,996	3,607	3,506	3,645	3,331	2,900	2,456
Participation rate (%)	51.0	36.4	38.7	41.4	42.0	43.2	46.9	51.9	59.2	64.1
<b>Merged cells</b>										
Solomon	442	1,461	2,066	2,357	2,188	2,057	2,224	2,108	2,134	1,772
Eligible participants	750	2,991	3,994	4,155	3,634	3,398	3,427	3,006	2,931	2,355
Participation rate (%)	58.9	48.8	51.7	56.7	60.2	60.5	64.9	68.8	72.8	75.2
<b>Northern Territory (Total)</b>										
Total participants	734	2,519	3,531	4,010	3,703	3,573	3,934	3,638	3,687	3,346
Eligible participants	1,322	5,901	7,783	8,151	7,241	6,904	7,072	6,397	5,891	4,811
Participation rate (%)	55.5	42.7	45.4	49.2	51.1	51.8	55.6	60.0	66.0	69.5
<b>Australian Capital Territory Divisions</b>										
Canberra(d)	1,764	4,789	4,817	4,973	4,626	4,453	5,074	4,826	5,189	4,394
Eligible participants	2,260	6,471	6,448	6,509	5,963	5,805	6,302	5,902	6,044	5,067
Participation rate (%)	78.1	74.0	74.7	76.4	77.3	76.7	80.5	81.8	85.5	86.9
<b>Femmer(e)</b>										
Total participants	1,477	4,687	5,178	5,786	6,025	5,463	5,181	4,208	3,948	3,465
Eligible participants	1,904	6,354	7,123	7,822	7,960	7,155	6,480	5,206	4,692	3,945
Participation rate (%)	77.6	73.8	72.7	74.0	75.7	76.6	80.1	80.8	84.1	87.8
<b>NA Yeah</b>										
Total participants	5,241	8,470	9,599	10,759	10,071	9,915	10,269	9,034	8,117	7,059
Eligible participants	4,164	12,825	13,569	14,331	13,943	12,960	12,782	11,108	10,736	9,002
Participation rate (%)	77.8	73.9	73.7	75.1	76.4	76.5	80.3	81.3	84.9	87.3
<b>Australia</b>										
Total participants	151,297	438,166	441,658	480,548	462,206	479,360	524,620	517,693	543,449	506,799
Eligible participants	201,439	635,909	646,916	665,250	656,446	660,841	693,850	659,150	664,720	587,386


**Tidying the Australian Same Sex Marriage Postal Survey Data with R**

This week the Australian Bureau of Statistics delivered the result the majority of us had hoped for but at the same time kind of expected...

[medium.com](https://medium.com)

6:43 AM - 19 Nov 2017

71 Retweets 238 Likes








 7
  71
  238
 

Figure 9.1: Tweet by Miles McBain about tidying the Australian Marriage Survey results with R

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	 <b>Australian Bureau of Statistics</b>															
2	<b>1800.0 Australian Marriage Law Postal Survey, 2017</b>															
3	Released on 15 November 2017															
4	<b>Table 2 Response by Federal Electoral Division(a)</b>															
5	<b>Response clear</b>								<b>Eligible Participants</b>							
6		<b>Yes</b>	<b>No</b>	<b>Total</b>					<b>Response clear</b>	<b>Response not clear(b)</b>	<b>Non-responding</b>	<b>Total</b>				
164	<b>Tasmania Divisions</b>															
165	Bass	36,249	61.7	22,510	38.3	58,759	100		58,759	79.0	145	0.2	15,487	20.8	74,391	100
166	Braddon	30,054	54.0	25,573	46.0	55,627	100		55,627	75.8	154	0.2	17,632	24.0	73,413	100
167	Denison	45,005	73.8	15,992	26.2	60,997	100		60,997	82.1	167	0.2	13,092	17.6	74,256	100
168	Franklin	44,746	68.8	20,322	31.2	65,068	100		65,068	82.5	163	0.2	13,605	17.3	78,836	100
169	Lyons	35,894	58.7	25,258	41.3	61,152	100		61,152	77.9	176	0.2	17,204	21.9	78,532	100
170	<i>Tasmania (Total)</i>	191,948	63.6	109,655	36.4	301,603	100		301,603	79.5	805	0.2	77,020	20.3	379,428	100
171																
172	<b>Northern Territory Divisions</b>															
173	Lingiari(c)	19,026	54.5	15,898	45.5	34,924	100		34,924	50.0	106	0.2	34,854	49.9	69,884	100
174	Solomon	29,660	65.3	15,792	34.7	45,452	100		45,452	66.6	123	0.2	22,642	33.2	68,217	100
175	<i>Northern Territory (Total)</i>	48,686	60.6	31,690	39.4	80,376	100		80,376	58.2	229	0.2	57,496	41.6	138,101	100
176																
177	<b>Australian Capital Territory Divisions</b>															
178	Canberra(d)	89,590	74.1	31,361	25.9	120,951	100		120,951	83.1	281	0.2	24,399	16.8	145,631	100
179	Fenner(e)	85,869	74.0	30,159	26.0	116,028	100		116,028	81.4	253	0.2	26,196	18.4	142,477	100
180	<i>Australian Capital Territory (Total)</i>	175,459	74.0	61,520	26.0	236,979	100		236,979	82.3	534	0.2	50,595	17.6	288,108	100

### 9.1.1 The full code listing

```

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

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

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

table_2 <-
  cells %>%
  dplyr::filter(sheet == "Table 2",
    row >= 5L,
    !is_blank) %>%

```

```

mutate(character = str_trim(character)) %>%
behead("NNW", "population") %>%
behead("NNW", "response") %>%
behead("N", "unit") %>%
behead("W", "territory") %>%
enhead(state, "NNW") %>%
arrange(row, col) %>%
select(row, data_type, numeric, state, territory, population, response,
       unit) %>%
spatter(unit) %>%
select(-row)

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

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

```

## 9.1.2 Step by step

### 9.1.2.1 Table 1

The first rows, up to the column-headers, must be filtered out. The trailing rows below the table will be treated as row-headers, but because there is no data to join them to, they will be dropped automatically. That is handy, because otherwise we would have to know where the bottom of the table is, which is likely to change with later editions of the same data.

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

```

cells <- xlsx_cells(smungs::ozmarriage)

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

```

```
select(-row)

table_1

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

### 9.1.2.2 Table 2

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

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

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

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

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

```

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

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

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

```