Book Clustering Statistics

This notebook provides statistics on the results of our book clustering.

Setup

```
library(tidyverse, warn.conflicts=FALSE)
```

```
── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
✔ dplyr     1.1.4     ✔ readr     2.1.4
✔ forcats   1.0.0     ✔ stringr   1.5.1
✔ ggplot2   3.4.4     ✔ tibble    3.2.1
✔ lubridate 1.9.3     ✔ tidyr     1.3.0
✔ purrr     1.0.2
── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()
ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all
conflicts to become errors
```

```
library(arrow, warn.conflicts=FALSE)
```

I want to use `theme_minimal()` by default:

```
theme_set(theme_minimal())
```

And default image sizes aren't great:

```
options(repr.plot.width  = 7,
        repr.plot.height = 4)
```

Load Data

Let's start by getting our clusters and their statistics:

```
clusters = read_parquet("book-links/cluster-stats.parquet", as_data_frame=FALSE)
glimpse(clusters)
```

```
Table
40,604,472 rows x 8 columns
$ cluster        <int32> 423896385, 454491654, 424930878, 449145631, 440372971, …
$ n_nodes       <uint32> 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2…
$ n_isbns       <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
$ n_loc_recs    <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
$ n_ol_editions <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
```

```
$ n_ol_works    <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
$ n_gr_books    <uint32> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1…
$ n_gr_works    <uint32> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1…
```

Describe the count columns for basic descriptive stats:

```
clusters %>%
  select(-cluster) %>%
  collect() %>%
  summary()
```

```
    n_nodes             n_isbns           n_loc_recs        n_ol_editions
 Min.   :     1.00   Min.   :    0.00   Min.   :   0.0000   Min.   :    0.00
 1st Qu.:     2.00   1st Qu.:    0.00   1st Qu.:   0.0000   1st Qu.:    1.00
 Median :     3.00   Median :    1.00   Median :   0.0000   Median :    1.00
 Mean   :     3.39   Mean   :    1.09   Mean   :   0.2382   Mean   :    1.14
 3rd Qu.:     4.00   3rd Qu.:    2.00   3rd Qu.:   0.0000   3rd Qu.:    1.00
 Max.   :105055.00   Max.   :50785.00   Max.   :1439.0000   Max.   :43970.00
   n_ol_works          n_gr_books         n_gr_works
 Min.   :   0.0000   Min.   :   0.000   Min.   :  0.00000
 1st Qu.:   1.0000   1st Qu.:   0.000   1st Qu.:  0.00000
 Median :   1.0000   Median :   0.000   Median :  0.00000
 Mean   :   0.8284   Mean   :   0.058   Mean   :  0.03748
 3rd Qu.:   1.0000   3rd Qu.:   0.000   3rd Qu.:  0.00000
 Max.   :2329.0000   Max.   :7380.000   Max.   :296.00000
```

75% of clusters only contain 2 ISBNs (probably -10 and -13) and one book. OpenLibrary also contributes to the largest number of clusters.

Clusters per Source

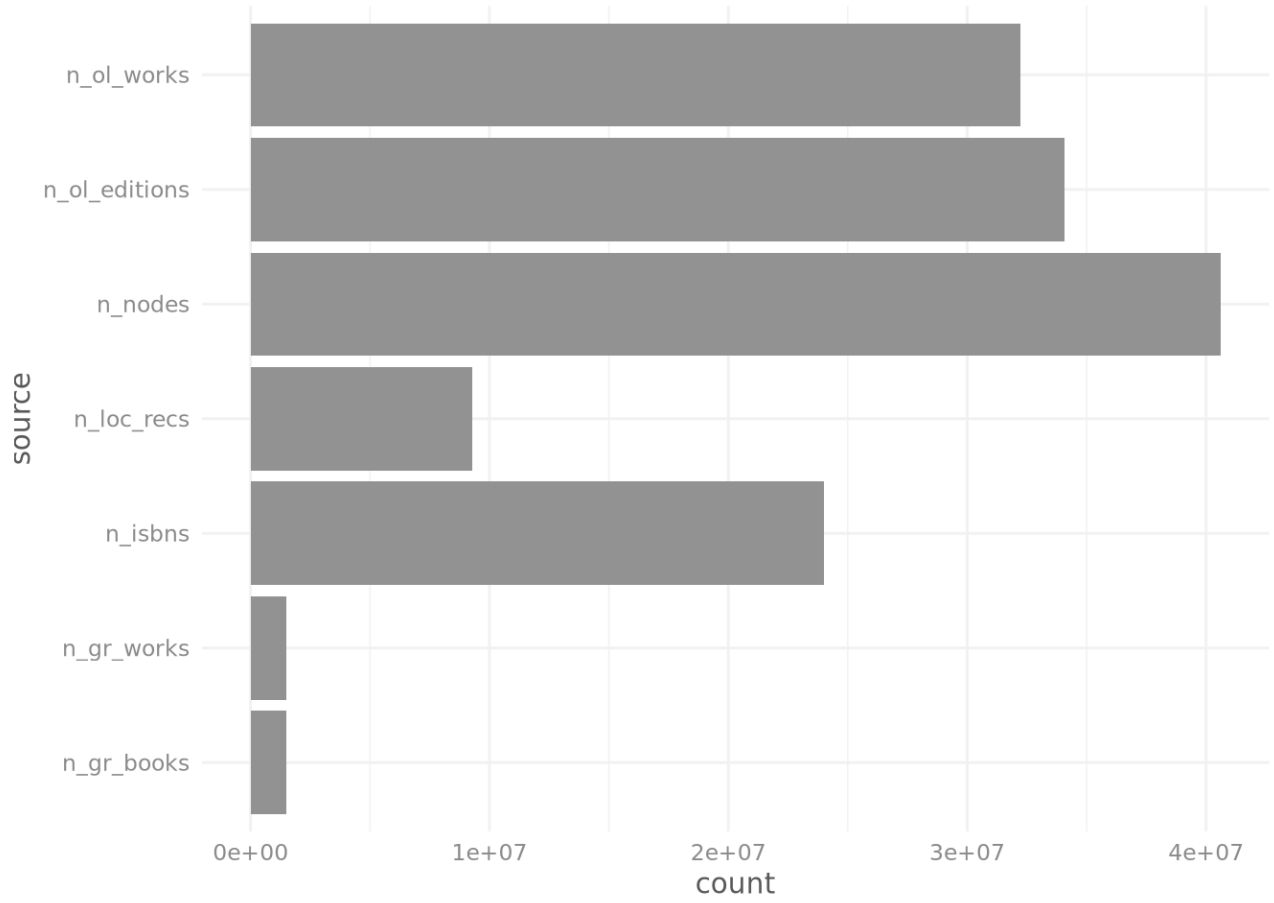
How many clusters are connected to each source?

```
src_counts = clusters %>%
  summarize(across(-cluster, ~ sum(.x > 0))) %>%
  collect() %>%
  pivot_longer(everything(), names_to="source", values_to="count")
src_counts
```

```
# A tibble: 7 × 2
  source           count
  <chr>            <int>
1 n_nodes       40604472
2 n_isbns       23987846
3 n_loc_recs     9278233
4 n_ol_editions 34071860
5 n_ol_works    32228071
```

```
6 n_gr_books     1505252
7 n_gr_works     1504728
```

```
ggplot(src_counts, aes(y=source, x=count)) +
  geom_bar(stat='identity')
```



Distributions

Let's look at the distributions of cluster sizes. Let's first compute histograms of the number of records per cluster for each cluster type.

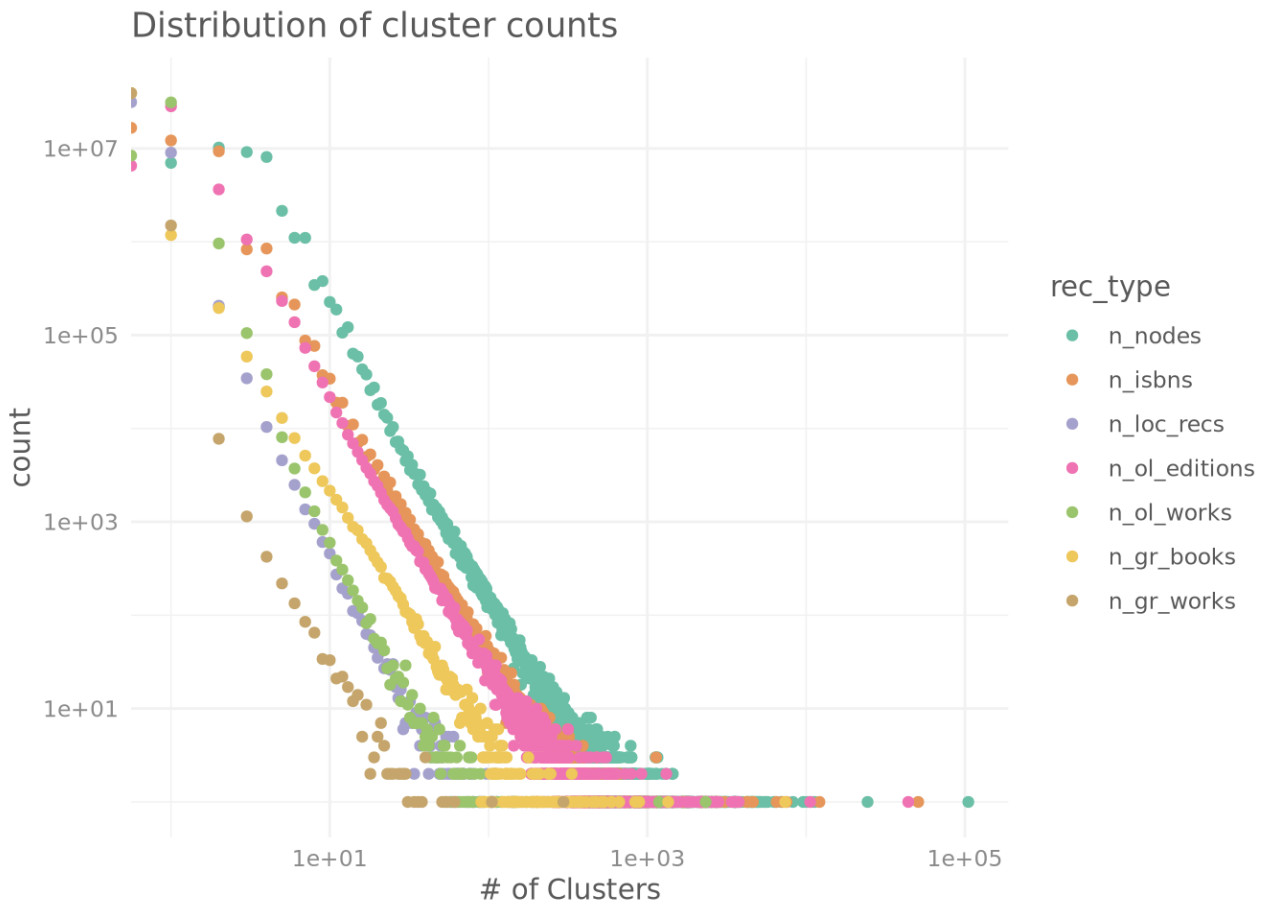
```
size_dists = collect(clusters) %>%
  gather(rec_type, nrecs, -cluster, factor_key=TRUE) %>%
  summarize(count=n(), .by=c("rec_type", "nrecs"))
head(size_dists)
```

```
# A tibble: 6 × 3
  rec_type nrecs    count
  <fct>    <int>    <int>
1 n_nodes      2 10209603
2 n_nodes      1  7001088
3 n_nodes      3  9138176
4 n_nodes      4  8093059
```

```
5 n_nodes       5  2145067
6 n_nodes       6  1103729
```

```
ggplot(size_dists) +
  aes(x=nrecs, y=count, color=rec_type) +
  geom_point() +
  scale_x_log10() +
  scale_y_log10() +
  scale_color_brewer(type="qual", palette="Dark2") +
  xlab("# of Records") +
  xlab("# of Clusters") +
  ggtitle("Distribution of cluster counts")
```

```
Warning: Transformation introduced infinite values in continuous x-axis
```



Looks mostly fine - we expect a lot of power laws - but the number of clusters with merged GoodReads works is concerning.

GoodReads Work Merging

What's going on with these clusters? Let's take a peek at them.

```
gr_big = clusters %>%
  filter(n_gr_works > 1) %>%
  arrange(desc(n_gr_works))
gr_big %>% glimpse()
```

```
Table (query)
10,044 rows x 8 columns
$ cluster        <int32> 100059755, 100032170, 100156279, 100124809, 100428296, …
$ n_nodes       <uint32> 105055, 9584, 513, 1602, 315, 337, 513, 304, 685, 610, …
$ n_isbns       <uint32> 50785, 4624, 192, 780, 141, 91, 225, 120, 245, 299, 248…
$ n_loc_recs    <uint32> 1439, 281, 6, 55, 1, 38, 6, 3, 2, 0, 0, 1, 105, 113, 0,…
$ n_ol_editions <uint32> 43970, 3720, 110, 462, 51, 64, 113, 75, 185, 170, 153, …
$ n_ol_works    <uint32> 1185, 341, 75, 78, 18, 58, 38, 21, 75, 45, 47, 25, 185,…
$ n_gr_books    <uint32> 7380, 513, 69, 172, 53, 46, 91, 45, 140, 60, 51, 46, 49…
$ n_gr_works    <uint32> 296, 105, 61, 55, 51, 40, 40, 40, 38, 36, 34, 31, 30, 3…
Call `print()` for query details
```

We have a lot of these clusters. What fraction of the GoodReads-affected clusters is this?

```
nrow(gr_big) / sum(!is.na(clusters$n_gr_books))
```

```
Scalar
0.0002473619161948467
```

Less than 1%. Not bad, but let's look at these largest clusters.

```
gr_big %>% head() %>% collect()
```

```
# A tibble: 6 × 8
    cluster n_nodes n_isbns n_loc_recs n_ol_editions n_ol_works n_gr_books
      <int>   <int>   <int>      <int>         <int>      <int>      <int>
1 100059755  105055   50785       1439         43970       1185       7380
2 100032170    9584    4624        281          3720        341        513
3 100156279     513     192          6           110         75         69
4 100124809    1602     780         55           462         78        172
5 100428296     315     141          1            51         18         53
6 100673490     337      91         38            64         58         46
# i 1 more variable: n_gr_works <int>
```

Large Cluster Debugging

We have some pretty big clusters:

```
big = clusters %>% slice_max(n_nodes, n=5, with_ties=FALSE) %>%
  collect()
big
```

```
# A tibble: 5 × 8
    cluster n_nodes n_isbns n_loc_recs n_ol_editions n_ol_works n_gr_books
      <int>   <int>   <int>      <int>         <int>      <int>      <int>
1 100059755  105055   50785       1439         43970       1185       7380
2 100510835   24374   12126        190         10610         68       1352
3 108162346   11281    7520          0          3760          1          0
4 102285712   10678    7118          0          3559          1          0
5 100148394   10118    6518          7          3558         35          0
# i 1 more variable: n_gr_works <int>
```

What is up with this? We should figure out what went wrong, if we can. What are its ISBNs?

```
isbns = read_parquet('book-links/all-isbns.parquet', as_data_frame=FALSE)
glimpse(isbns)
```

```
Table
44,293,137 rows x 8 columns
$ isbn_id     <int32> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17,…
$ isbn <large_string> "1858338956", "9789401010498", "9788412175912", "978176089…
$ LOC         <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0…
$ OL          <uint32> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1…
$ GR           <int64> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
$ BX          <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
$ AZ14        <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
$ AZ18        <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
```

```
links = read_parquet("book-links/isbn-clusters.parquet", as_data_frame=FALSE) %>%
  select(isbn_id, cluster)
glimpse(links)
```

```
Table (query)
44,293,137 rows x 2 columns
$ isbn_id <int32> 44293137, 44293136, 44293135, 44293134, 44293133, 44293132, 44…
$ cluster <int32> 944293137, 944293136, 944293135, 944293134, 944293133, 9442931…
Call `print()` for query details
```

Now let's look up data for the largest cluster.

```
big_id = big$cluster[1]
big_id
```

```
[1] 100059755
```

```
bl = links %>% filter(cluster == big_id)
bl = semi_join(isbns, bl) %>% arrange(isbn)
bl %>% glimpse()
```

```
Table (query)
?? rows x 8 columns
$ isbn_id     <int32> 41743470, 41604450, 31743668, 13388484, 22829832, 21599315…
$ isbn <large_string> "0000744395", "000074445X", "0001004735", "0001004743", "0…
$ LOC         <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0…
$ OL          <uint32> 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 2, 3, 1…
$ GR           <int64> 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0…
$ BX          <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0…
$ AZ14        <uint32> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
$ AZ18        <uint32> 0, 0, 0, 0, 0, 0, 0, 75, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0…
Call `print()` for query details
```

What are the things with the highest record count?

```
bl %>% collect() %>% rowwise() %>% mutate(
  btot = sum(c_across(!starts_with("isbn")))
) %>% slice_max(btot, n=20)
```

```
# A tibble: 50,785 × 9
# Rowwise:
    isbn_id isbn         LOC    OL    GR    BX  AZ14  AZ18  btot
      <int> <chr>      <int> <int> <int> <int> <int> <int> <int>
 1 41743470 0000744395     0     0     1     0     0     0     1
 2 41604450 000074445X     0     0     1     0     0     0     1
 3 31743668 0001004735     0     1     0     0     0     0     1
 4 13388484 0001004743     0     1     0     0     0     0     1
 5 22829832 0001034375     0     1     0     0     0     0     1
 6 21599315 0001046403     0     1     0     0     0     0     1
 7 28169478 0001049283     0     1     0     0     0     0     1
 8 21578045 0001054783     0     1     0     0     0    75    76
 9 34988894 0001385208     0     1     0     0     0     0     1
10 12989061 0001660047     0     1     0     0     0     0     1
# i 50,775 more rows
```