Gathering Bibliometric Information using Scopus using rscopus

by John Muschelli

Abstract We demonstrate how to download author and affiliation using the `rscopus` package, interacting with the Elsevier Scopus API. We demonstrate how to manipulate the output from the API into organized data that can be analyzed. We present options on how to calculate the number of citations from an author, as well as calculating citation metrics with the output.

Introduction

Elsevier provides a number of APIs (application program interfaces) to extract information about science and research (`https://dev.elsevier.com/`). This information is can provide insights into how research is done and provide the data to perform experiments and analyses of metascience. In many cases, we would like to gather information about publications, authors, and institutions with respect to published research. Elsevier's Scopus a repository of information about scientific articles and books, which includes information about authors, citations, and abstracts. Scopus claims to have the largest database of this information (`https://www.elsevier.com/solutions/scopus`). Therefore, providing users an interface to this repository should be worthwhile.

One common task for researchers is to keep his or her curriculum vitae (CV) up to date. That requires having accurate information on the papers published and under submission. Keeping track of these papers can be tedious and solutions could exist if one could retrieve papers automatically. One concern is missing certain crucial papers in your CV. Although **rscopus** does not provide these tools specifically, it can be used to consistently cross-reference information about publications with a CV.

Additionally on CVs, one may present information of the impact of a paper. This can be done by highlighting certain pieces of information, such is done in NIH biosketches, or ranking papers based on some metric. As promotions and grant review may be affected by highlighting impact, these metrics can have real-life implications. One metric commonly used is the number of citations. Also, information about the journal impact factor may be taken into account. We do not imply that these are particularly good metrics or metrics that reflect true impact, but are simply those that we have seen used in practice.

The **rscopus** package allows you to interface with Scopus APIs and gather information about authors, affiliations, articles, and abstracts. Currently in R, packages exist for bibliometric analysis, but commonly require the data to be downloaded from a website or online interface. For example, the **bibliometrix** (Aria and Cuccurullo, 2017) package provides a level of integration that is useful for using multiple packages that deal with bibliometric data, incorporating functionality from **rscopus**. The **bibliometrix** package also enables users to analyze data from ISI Web of Knowledge (WoK) and PubMed.

Web of Knowledge is one competitor to Scopus, but **bibliometrix** does not have an interface to the WoK API; therefore data must be manually exported from the site into R. Additional access to the web of Science API would be useful and has been implemented in a GitHub package **rwos** (`https://github.com/juba/rwos`), but is not on CRAN and has not been updated recently (over 1 year). We have also created an interface with the Web of Science APIs (`https://github.com/muschellij2/webofscience`), but have not been given access to the APIs to test them as it is still in beta.

As compared to Google Scholar, Scopus and WoK claim the information from these sources is more curated. Other packages such as **scholar** (Keirstead, 2016) and **gcite** (Muschelli, 2018) can provide interfaces to the Google Scholar citation information. Using these in combination with **rscopus** can more likely guarantee complete information. Also, comparing these different repositories can demonstrate biases or differences in the number of citations across the different platforms.

Scopus has a number of APIs available (`https://dev.elsevier.com/sc_apis.html`). Here we will present examples of how to use the **rscopus** package, including: searching for authors or affiliations, calculating citation indices for an author, retrieving abstract information on articles, and downloading artifacts from an article.

API Key

Before using the package, one must obtain an access key to the API from Elsevier with the following steps:

1. Go to `https://dev.elsevier.com/user/login`. Login or create a free account.
2. Click "Create API Key". Put in a label, such as "`rscopus key`". Add a website. `http://example.com` is fine if you do not have a site.
3. **Read** and agree to the terms of service if you do indeed agree.
4. Add `Elsevier_API = "API KEY GOES HERE"` to `~/.Renviron` file, or add `export Elsevier_API=API KEY GOES HERE` to your `~/.bash_profile`.

Alternatively, you you can either set the API key using `rscopus::set_api_key`, which will implicitly set `options("elsevier_api_key" = api_key)`. You can access the API key using `rscopus::get_api_key`.

You should be able to test out the API key using the interactive Scopus APIs.

Once you have an API key set up, you can access the key using `get_api_key`, which will check multiple places for the presence of the key:

```
library(rscopus)
key = get_api_key()
```

As you may want to hide this key from documents, the default print options do not display it:

```
key
```

```
<hidden api key, use print(, reveal = TRUE) to see it>
```

There are other helpful functions for testing if an API key exists, such as `have_api_key`:

```
have_api_key()
```

```
[1] TRUE
```

In each function, you may pass in the API key as the argument `api_key` as well, rather than specifically look in the `~/.Renviron` or `options()`.

A note about API keys and IP addresses

The API Key is bound to a set of IP addresses, usually from your institution or organization (see `https://dev.elsevier.com/tecdoc_api_authentication.html`). Therefore, if you are using **rscopus** for a Shiny application, you must host the Shiny application from the institution/organization servers in some way. Also, you cannot access the Scopus API with this key if you are offsite and must VPN into the server or use a computing cluster with an institution IP.

Methods: Use cases

In this section we will present some use cases for the API, focusing on retrieving information about authors and affiliations.

Processing author names to identifiers

Researchers commonly would like to gather information about a set of authors. Most times the authors are the given by first and last names or initials; additional information such as affiliation may be available. Scopus provides unique identifier for authors (`au_id`) or affiliations (`affil_id`), amongst others. In many cases with the API, you will specify the author identifier (`au_id`) instead of a first and last name, as there may be many authors with the same name. In order to get the author identifier from Scopus, you can search using a first and last name using the `process_author_name` command. For example, let us try to identify the author ID for John Muschelli:

```
auth_info = process_author_name(last_name = "Muschelli", first_name = "John",
                                verbose = FALSE)
auth_info
```

```
$au_id
[1] "40462056100"

$first_name
[1] "John"

$last_name
[1] "Muschelli"
```

The output is a simple list of first and last name with an author ID. The function chooses the first author found, which may be useful if the author name is somewhat unique. We will show below how to search when the name is not as unique. This identifier is unique to this author, though curation errors do happen and someone may have 2 unique identifiers. These identifiers can be merged by request on the Scopus website.

Retrieving author citation data

In order to get data about papers and citations from an author, the `author_data` function will retrieve this information:

```
jm = author_data(last_name = "Muschelli", first_name = "John", verbose = FALSE)
```

We see the output is a list of the converted `entries` from the JSON output Scopus API, a `data.frame` of the results for citations, and a list named `full_data`:

```
class(jm)
```

```
[1] "list"
```

```
names(jm)
```

```
[1] "entries"   "df"        "full_data"
```

The `data.frame` `df` has the information many users wish to retrieve, which is information about the author documents such as the Scopus ID for that paper (`dc:identifier`), the title of the paper (`dc:title`), and the number of citations (`citedby-count`).
Here we present `short_title`, first 3 "relevant" words of the title (see `unique_title` in supplemental material), instead of the full document title from `dc:title` for viewing purposes as titles can be quite long.

```
jm$df$short_title = unique_title(jm$df$`dc:title`)
head(jm$df[, c("dc:identifier", "short_title", "citedby-count")])
```

```
          dc:identifier                          short_title
1 SCOPUS_ID:85053246791         Objective Evaluation Multiple
2 SCOPUS_ID:85043338865              MIMoSA: Automated Method
3 SCOPUS_ID:85047750078           Radiomic subtyping improves
4 SCOPUS_ID:85028874240      Feasibility Coping Effectiveness
5 SCOPUS_ID:85050271095     Freesurfer: Connecting Freesurfer
6 SCOPUS_ID:85009266881 Thrombolytic removal intraventricular
  citedby-count
1             0
2             1
3             3
4             2
5             0
6            49
```

We see that the `full_data` has this `df` inside it, with other `data.frames`:

```
names(jm$full_data)
```

```
[1] "df"          "affiliation" "author"
```

These `data.frames` can have additional information about co-author affiliations or co-author information. This information may be useful for creating network graphs. For example, to get all authors from all the papers, you can use the `author` element from `full_data`:

```
head(jm$full_data$author[, c("authid", "authname", "surname", "afid.$", "entry_number")])
```

```
       authid     authname   surname   afid.$ entry_number
1  8431704700 Commowick O. Commowick 60030553            1
2 57203861434    Istace A.    Istace 60001780            1
3 57199507814      Kain M.      Kain 60030553            1
4 57197801981   Laurent B.   Laurent 60105610            1
5 57203867656     Leray F.     Leray 60030553            1
6 57203864793     Simon M.     Simon 60030553            1
```

The column entry_number indicates which element this information came in the entry list (retrieved from httr::content, which calls jsonlite:fromJSON). This column should merge with the data.frame of citations, as well as the information about author affiliations, which is located in the affiliation data.frame from full_data:

```
head(jm$full_data$affiliation[, c("afid", "affilname", "affiliation-country", "entry_number")])
```

```
      afid
1 60030553
2 60001780
3 60105610
4 60062760
5 60028893
6 60028893
                                                             affilname
1                                                  Universite de Rennes 1
2                                             Centre Hospitalier Lyon-Sud
3                     Laboratoire de Traitement de l'Information Medicale
4 Centre de Recherche en Acquisition et Traitement d'Images pour la Sante
5                               Centre Hospitalier Universitaire de Rennes
6                               Centre Hospitalier Universitaire de Rennes
  affiliation-country entry_number
1             France            1
2             France            1
3             France            1
4             France            1
5             France            1
6             France            1
```

This information is rich for understanding information about an author's publication record, how many citations are recorded for a specific article, which journals have been published in, and who has co-authored publications with an author. For example, one could determine how many international collaborators an author had on papers.

Retrieving summary information about an author

The author_retrieval function can gather summary information about an author using the author identifier or name.

```
author_info = author_retrieval(last_name = "Muschelli", first_name = "J")
```

```
       auth_name       au_id affil_id
1 John Muschelli 40462056100 60006183
                                    affil_name
1 Johns Hopkins Bloomberg School of Public Health
```

```
names(author_info$content)
```

```
[1] "author-retrieval-response"
```

```
class(author_info$content$`author-retrieval-response`)
```

```
[1] "list"
```

In the standard output from the Scopus API after conversion in httr, there are elements of the list named entries or entry. The low-level function gen_entries_to_df attempts to coerce this list into a standard data.frame for more usability, but may not perform perfectly as lists from JSON cannot always be directly coerced into a rectangular format. For example, here we will convert that output into a data.frame:

```
gen_entries_to_df(author_info$content$`author-retrieval-response`)$df
```

```
  @status @_fa
1   found true
                                           coredata.prism:url
1 http://api.elsevier.com/content/author/author_id/40462056100
  coredata.dc:identifier       coredata.eid      coredata.orcid
1  AUTHOR_ID:40462056100 9-s2.0-40462056100 0000-0001-6469-1750
  coredata.document-count coredata.cited-by-count coredata.citation-count
1                      36                     681                     804
                                                                                 coredata.link.@href
1 https://www.scopus.com/authid/detail.uri?partnerID=HzOxMe3b&authorId=40462056100&origin=inward
  coredata.link.@rel coredata.link.@_fa preferred-name.surname
1      scopus-author               true              Muschelli
  preferred-name.given-name preferred-name.initials
1                      John                      J.
            affiliation-current.affiliation-name
1 Johns Hopkins Bloomberg School of Public Health
  affiliation-current.affiliation-city
1                            Baltimore
  affiliation-current.affiliation-country publication-range.start
1                           United States                    2011
  publication-range.end entry_number
1                  2018            1
```

but this list from author_retrieval typically only has one element, and may be easily referenced using $ as a list. Overall, author_retrieval gives general info about an author, but this information and more can likely be extracted using the author_data function above.

Calculating author indices

With the data from the author_data output (jm$df), we can calculate citation indices. Here we calculate the overall h-index (Hirsch, 2005). We will use **dplyr** (Wickham et al., 2018) for data manipulation:

```
library(dplyr)
h_data = jm$df %>%
  mutate(citations = as.numeric(`citedby-count`)) %>%
  arrange(-citations) %>%
  mutate(n_papers = 1:n())
head(h_data[, c("short_title", "citations", "n_papers")])
```

```
                             short_title citations n_papers
1             Minimally invasive surgery       141        1
2     Disruption functional organization        68        2
3     Reduction motion-related artifacts        63        3
4          Minimally invasive evacuation        54        4
5 Resolution intraventricular hemorrhage        50        5
6  Thrombolytic removal intraventricular        49        6
```

```
h_index = max(which(h_data$citations >= h_data$n_papers))
h_index
```

```
[1] 15
```

Using **ggplot2** (Wickham, 2016), we can also visually show the h-index computation, where we plot the number of citations versus the number of papers (cumulatively) along with the X-Y line:

```
library(ggplot2)
h_data %>%
  ggplot(aes(x = n_papers, y = citations)) +
  geom_point() + geom_abline(slope = 1, intercept = 0) +
  geom_hline(yintercept = h_index, color = "red")
```

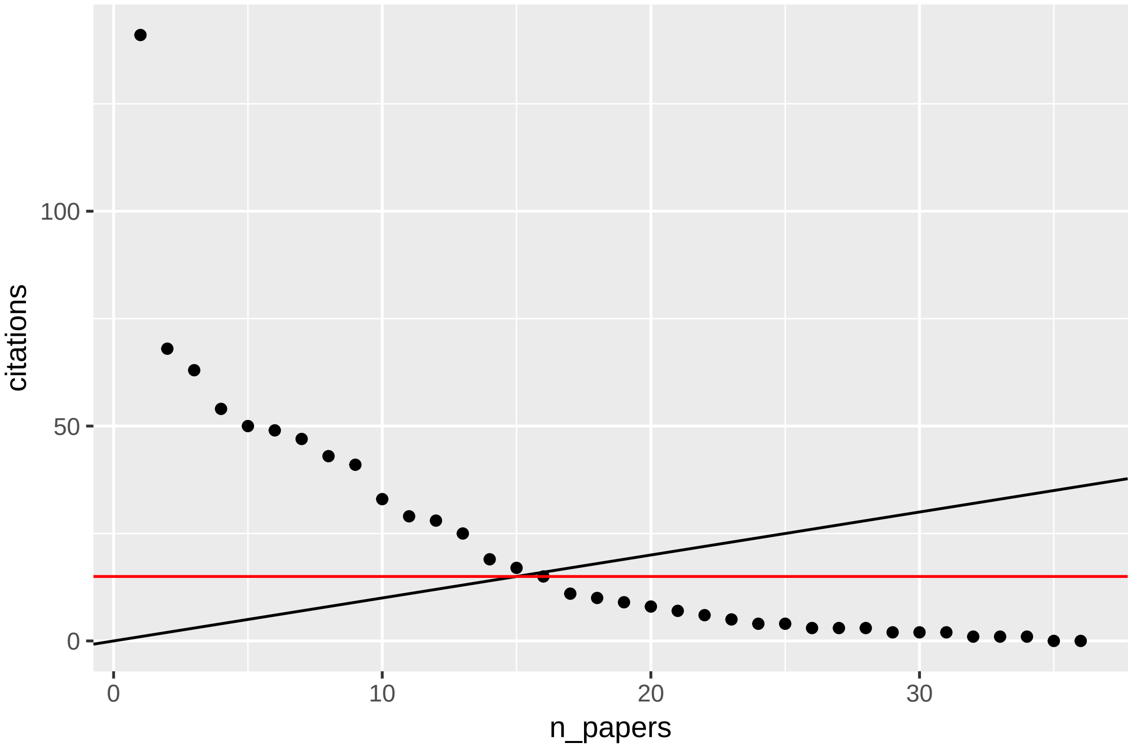


Figure 1: Calculating an h-index. Here we plot the number of papers versus the number of citations for that paper. This plot is the basis for the h-index. The X=Y line is displayed in black and the red line is where the curve passes the X=Y line, which is the h-index, a value of 15.

Additional indices can be created from the data, such as the *g*-index (Egghe, 2006):

```
h_data = h_data %>% mutate(sum_citations = cumsum(citations))
g_index = max(which(h_data$sum_citations >= h_data$n_papers^2))
g_index
```

```
[1] 28
```

Overall, metrics based on citations and the year of publication can be calculated, but longitudinal information is lacking. We will discuss citation information over time in Section 2.2.7.

Retrieving information about an author

In process_author_name, we demonstrated how to get information form an author with a relatively unique name. If this is not the case, the get_complete_author_info, which is the backend function for process_author_name, can present more results. In order to retrieve author IDs from first and last names, the get_complete_author_info can be used. Here we search for authors with the last name West and first initial M:

```
last_name = "West"
first_name = "M"
auth_info_list = get_complete_author_info(last_name = last_name, first_name = first_name)
class(auth_info_list)
```

```
[1] "list"
```

```
names(auth_info_list)
```

```
[1] "get_statement" "content"
```

We see here, which is common in in some low-level functions returned from the rscopus API, the output is a list with elements get_statement, which returns an object of class response (from the **httr** package (Wickham, 2017)), and content, which is the content from the response. Most times, the content is of interest, but failed requrests may be explored with the get_statement output for debuggin.

Again, we can use gen_entries_to_df convert that output into a data.frame, which is more manageable:

```
coerced = gen_entries_to_df(auth_info_list$content$`search-results`$entry)
names(coerced)
```

```
[1] "df"           "name-variant" "subject-area"
```

```
head(coerced$df[, c("dc:identifier",  "preferred-name.surname",
                    "preferred-name.given-name", "affiliation-current.affiliation-name" )])
```

```
          dc:identifier preferred-name.surname preferred-name.given-name
1 AUTHOR_ID:35480328200                   West                 Catharine
2 AUTHOR_ID:35419377800                   West                Malcolm J.
3  AUTHOR_ID:7003392768            Diener-West                     Marie
4  AUTHOR_ID:7402395730                   West                 Robert M.
5  AUTHOR_ID:7402068812                   West           Michael Abigail
6  AUTHOR_ID:7401998578                   West                  David M.
            affiliation-current.affiliation-name
1                        University of Manchester
2                James Cook University, Australia
3 Johns Hopkins Bloomberg School of Public Health
4                             University of Leeds
5         University of Pittsburgh Medical Center
6                               Massey University
```

We see this has information about the multiple authors returned, along with names, variations on those names, number of documents, and affiliations. We can then extract the author ID we want from this data.frame. This process is wrapped in the get_author_info:

```
auth_info_df = get_author_info(last_name = last_name,
                               first_name = first_name)
head(auth_info_df)
```

```
            auth_name       au_id          affil_id
1       Catharine West 35480328200          60003771
2      Malcolm J. West 35419377800          60019870
3    Marie Diener-West  7003392768          60006183
4       Robert M. West  7402395730          60012070
5 Michael Abigail West  7402068812 60012018 60023691
6        David M. West  7401998578          60008221
                                       affil_name
1                        University of Manchester
2                James Cook University, Australia
3 Johns Hopkins Bloomberg School of Public Health
4                             University of Leeds
5         University of Pittsburgh Medical Center
6                               Massey University
```

but we should note this information is condensed and a subset that is available from get_complete_author_info, also with more standardized column names. Now, one could use the au_id retrieved from this output for searching.

If you had an affiliation ID, such as 60006183 for the Johns Hopkins Bloomberg School of Public Health, we can pass this to get_author_info or process_author_name:

```
spec_affil = get_author_info(
  last_name = last_name,
  first_name = first_name,
  affil_id = 60006183)
spec_affil
```

```
          auth_name      au_id affil_id
1 Marie Diener-West 7003392768 60006183
                                       affil_name
1 Johns Hopkins Bloomberg School of Public Health
```

Thus, we can use the combination of the names of the author and affiliation information. This may be useful when searching multiple authors at the same institution. We could also pass in `affil_name` instead of `affil_id` to `get_author_info`, but the name must be extremely specific for institution as the function will call `get_affiliation_info`, which is discussed below.

Retrieving information about multiple authors

In order to get information from multiple authors, one could loop over author information, but this is inefficient for code and API calls. The `complete_multi_author_info` function can perform this operation. One caveat is that it requires author identifiers and not names. We can take the author IDs from `auth_info_df` to retrieve information for all these authors:

```
all_author_info = complete_multi_author_info(au_id = auth_info_df$au_id)
names(all_author_info)
```

```
[1] "get_statement" "content"       "au_id"
```

This result is again a low-level output from the API. We can use the `process_complete_multi_author_info` function to process this into a more amenable solution:

```
processed = process_complete_multi_author_info(all_author_info)
head(names(processed))
```

```
[1] "35480328200" "35419377800" "7003392768"  "7402395730"  "7402068812"
[6] "7401998578"
```

Now, each element is the author ID, which contains a list of `data.frames`. The `multi_author_info` will perform both of these operations together. This result is still not "tidy" (Wickham et al., 2014) in many respects, but parts can be combined using **purrr** (Henry and Wickham, 2018):

```
journals = purrr:::map_df(processed, `$`, "journals", .id = "au_id")
head(journals)
```

```
        au_id type                                     sourcetitle
1 35480328200    j                                  Cancer Letters
2 35480328200    j   Journal of Cancer Research and Clinical Oncology
3 35480328200    j                           Nature Reviews Cancer
4 35480328200    j Annals of the Royal College of Surgeons of England
5 35480328200    j                                  Cancer Letters
6 35480328200    j                        PLoS Computational Biology
           sourcetitle-abbrev     issn
1                 Cancer Lett. 03043835
2 J. Cancer Res. Clin. Oncol. 01715216
3             Nat. Rev. Cancer 1474175X
4   Ann. R. Coll. Surg. Engl. 00358843
5                 Cancer Lett. 18727980
6           PLoS Comput. Biol. 1553734X
```

Thus, in the above code we could compare the journals each author published in compared to the other authors in the list.

Citations over time

Some APIs from Elsevier are disabled by default (see https://dev.elsevier.com/api_key_settings.html). Notably, the Citations Overview API is disabled, which allows users to access information about citations over time for articles of authors. This information is particularly useful for creating bibliometric indices that rely on subsetting data based on mininum or maximum year or calculating time-dependent metrics. The `rscopus` package interfaces with these APIs, but the API must be enabled for that specific API key. On the Scopus website one can searching for authors, select up to 15 authors, and then create a "Citation Overview", which will give this citation information, which is in a CSV format. The **rscopus** package provides a `read_cto` function to read in this data.

We also provide an example export from a single author in the package:

```
file = system.file("extdata", "CTOExport.csv", package = "rscopus")
citations_over_time = rscopus::read_cto(file)
names(citations_over_time)
```

```
[1] "data"               "year_columns"       "author_information"
```

The real information is in the data element of this list, which contains the yearly citation information (again titles have been shortened):

```
yr_cols = citations_over_time$year_columns
citations_over_time = citations_over_time$data
citations_over_time = citations_over_time %>%
  mutate(short_title = unique_title(`Document Title`))
head(citations_over_time[, c("short_title", yr_cols[1:5])])
```

```
                            short_title <2008 2008 2009 2010 2011
1        Objective Evaluation Multiple     0    0    0    0    0
2             MIMoSA: Automated Method     0    0    0    0    0
3          Radiomic subtyping improves     0    0    0    0    0
4      Feasibility Coping Effectiveness     0    0    0    0    0
5     Freesurfer: Connecting Freesurfer     0    0    0    0    0
6 Thrombolytic removal intraventricular     0    0    0    0    0
```

In the citation overview, you must specify a range of years on Scopus, with a maximum of 15 years. As many times this wide format is not what you want to plot, or in a "tidy" format, the **rscopus** helper function read_cto_long will read the data in long format, done by **tidyr** (Wickham and Henry, 2018). Here we use **dplyr** to arrange the data by maximum number of citations per year:

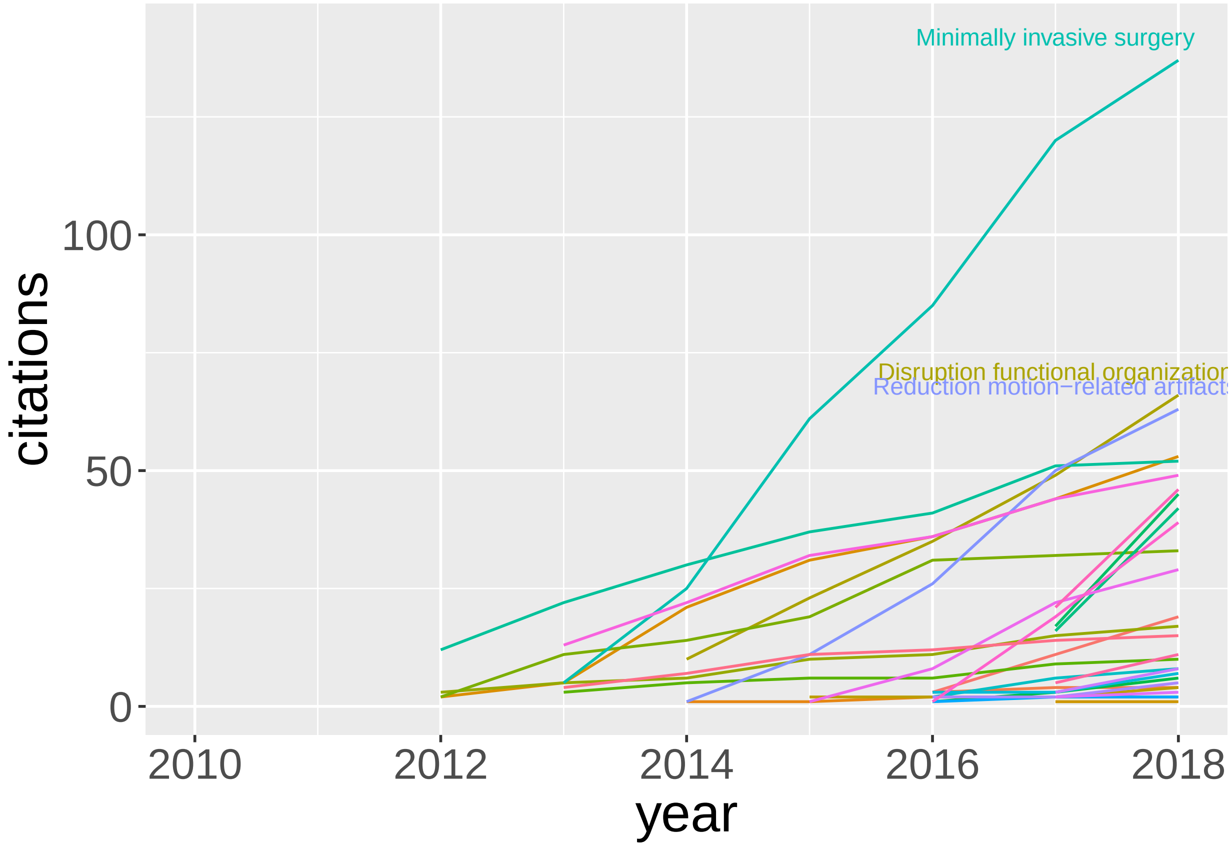
```
long_cite = rscopus::read_cto_long(file)
long_cite = long_cite$data %>%
  group_by(`Document Title`, year) %>% # get the citations per year
  summarize(citations = sum(citations), # aggregate - some duplicates merged
            `Publication Year` = unique(`Publication Year`)) %>% # keep the year in data
  mutate(short_title = unique_title(`Document Title`))
long_cite = long_cite %>% arrange(-citations, year, short_title)
head(long_cite[, c("short_title", "year", "citations")])
```

```
# A tibble: 6 x 3
  short_title                           year  citations
  <chr>                                 <fct>     <int>
1 Minimally invasive surgery            2015         36
2 Minimally invasive surgery            2017         35
3 ISLES 2015 public                     2018         28
4 Large-scale radiomic profiling        2018         26
5 Thrombolytic removal intraventricular 2018         25
6 Minimally invasive surgery            2016         24
```

Thus, we have one record per year and article. Here we will plot the cumulative citations per each paper over the years of publication and label the top 3 cited papers:

```
# get cumulative sum
csum = long_cite %>%
  # any missing data had no citations
  mutate(citations = ifelse(is.na(citations), 0, citations)) %>%
  arrange(`Document Title`, year) %>% # sort for cumsum
  group_by(`Document Title`) %>%
  mutate(citations = cumsum(citations))
# remove past and future with as.integer
csum = csum %>%
  mutate(year = as.integer(as.character(year))) %>%
  filter(!is.na(year)) %>% # remove < 2008 and > 2018 years
  filter(year >= `Publication Year` & citations > 0) # keep only relevant data for paper
# grab last citations and top 3 papers
last_year = csum %>%
  arrange(`Document Title`, year) %>% # sort for slice later
  group_by(`Document Title`) %>%
  slice(n()) %>% # keep last as max citations
  ungroup %>% arrange(-citations) %>%
  head(3)  # get top 3
g = ggplot(csum,
```

```
          aes(x = year, y = citations, color = short_title  )) +
  xlim(c(2010, 2018)) + geom_line() +
  # label the titles numbers for top 3
  geom_text(data = last_year, size = 3, aes(label = short_title),
            nudge_x = -1, nudge_y = 5)
# don't want label for document title - too many entries
g + guides(color = FALSE) + theme(text = element_text(size = 20))
```



Thus, we can present visually how the number of citations has changed and may be able to highlight which papers are gaining or waning in citations over time. This plot may not provide deep insights, but the same plot could be made by scientific sub-fields or for specific journals, which may indicate trends in published articles for example.

Retrieving affiliation information

In order to get information about an affiliation, the `get_affiliation_info` can be used. Here we will look for the pattern `Johns Hopkins`:

```
jhu_info = get_affiliation_info(affil_name = "Johns Hopkins")
head(jhu_info[, c("affil_id", "affil_name")])
```

```
  affil_id                                         affil_name
1 60005248                           Johns Hopkins University
2 60001117                  The Johns Hopkins School of Medicine
3 60006183        Johns Hopkins Bloomberg School of Public Health
4 60001555                             Johns Hopkins Hospital
5 60003443                   Johns Hopkins Medical Institutions
6 60022054 The Johns Hopkins University Applied Physics Laboratory
```

This function implicitly calls `affil_search`, a lower-level function which searches the affiliation information from Scopus. Additional information can be extracted using `affil_search`, but this typically includes a large number of records as it searches all the documents. This affiliation ID again can be used to be more specific when searching authors or documents.

Searching articles by abstract

In some cases, one may have an article in mind and would like information about the authors of that article In order to get the author IDs from the article identifier, one can use the abstract_retrieval function. There are multiple identifiers that can be used, such as PubMed ID, DOI, and we will use the Scopus ID as that is what is returned from the author_data output:

```
sc_id = jm$df$`dc:identifier`[1]
# retrieve abstract
res = abstract_retrieval(id = sc_id, identifier = "scopus_id")
```

Here we will extract the abstract information from the result:

```
sc_info = res$content$`abstracts-retrieval-response`
substr(sc_info$coredata$`dc:description`, 1, 220)
```

```
[1] "© 2018, The Author(s). We present a study of multiple sclerosis segmentation algorithms conducted at the
```

Here we can extract information about the authors of the paper:

```
sc_df = purrr::map_df(sc_info$authors[[1]],
  as.data.frame, stringsAsFactors = FALSE, make.names = FALSE)
head(sc_df[, c("ce.given.name", "ce.initials", "X.auid")])
```

```
  ce.given.name ce.initials      X.auid
1       Olivier          O.  8431704700
2        Audrey          A. 57203861434
3       Michaël          M. 57199507814
4      Baptiste          B. 57197801981
5       Florent          F. 57203867656
6       Mathieu          M. 57203864793
```

This information is located within the author data.frame from the full_data as well. Note, however that the information from author_data was obtained by searching Scopus for an author, whereas the information from abstract_retrieval was obtained by searching for a specific paper. As we took the first entry from the Scopus identifier, we will subset the author data by entry_number 1 from the author data.frame to show the relevant info matches:

```
paper_author_info = jm$full_data$author
head(paper_author_info[paper_author_info$entry_number == 1, c("authid", "authname", "surname")])
```

```
       authid     authname   surname
1  8431704700 Commowick O. Commowick
2 57203861434    Istace A.    Istace
3 57199507814      Kain M.      Kain
4 57197801981   Laurent B.   Laurent
5 57203867656     Leray F.     Leray
6 57203864793     Simon M.     Simon
```

Thus, if we retrieve a single author's information, we can gather other author IDs from this directly. If we have a specific paper, we can retrieve author IDs from that paper information as well.

Object retrieval

Along with metadata, abstract, and other information about a paper, additional objects may be accessed, such as figures, movies, or supplemental material The object_retrieval function will return the objects associated with the identifier. The process_object_retrieval will convert the output into a tidy data.frame:

```
objects = object_retrieval("S1053811915002700", identifier = "pii", verbose = FALSE)
obj_df = process_object_retrieval(objects)
head(obj_df[, c("type", "url", "mime_type")])
```

```
             type
1 IMAGE-THUMBNAIL
2 IMAGE-THUMBNAIL
3 IMAGE-THUMBNAIL
```

```
4 IMAGE-THUMBNAIL
5 IMAGE-THUMBNAIL
6 IMAGE-THUMBNAIL
                                                                                     url
1 https://api.elsevier.com/content/object/eid/1-s2.0-S1053811915002700-gr1.sml?httpAccept=image/gif
2 https://api.elsevier.com/content/object/eid/1-s2.0-S1053811915002700-gr2.sml?httpAccept=image/gif
3 https://api.elsevier.com/content/object/eid/1-s2.0-S1053811915002700-gr3.sml?httpAccept=image/gif
4 https://api.elsevier.com/content/object/eid/1-s2.0-S1053811915002700-gr4.sml?httpAccept=image/gif
5 https://api.elsevier.com/content/object/eid/1-s2.0-S1053811915002700-gr5.sml?httpAccept=image/gif
6 https://api.elsevier.com/content/object/eid/1-s2.0-S1053811915002700-gr6.sml?httpAccept=image/gif
  mime_type
1 image/gif
2 image/gif
3 image/gif
4 image/gif
5 image/gif
6 image/gif
```

where the URL provides the link to download the object. Here we will subset the output to high-resolution images, and pass the URL for the first to the download_object function. This will return the content of the image, as well as download the image to disk (with path outfile):

```
obj_df = obj_df[ grepl("image/jpeg", obj_df$mime_type),]
obj_df = obj_df[ obj_df$type %in% "IMAGE-HIGH-RES",]
object = download_object(obj_df$url[1])
object$outfile
```

```
[1] "/var/folders/1s/wrtqcpxn685_zk570bnx9_rr0000gr/T//RtmpisFIvB/file16fb63141e442.jpg"
```

One can then view the output using the system viewer using utils::browseURL. The download_objects function is a convenience wrapper for lapply(url, download_object) when passing in all the URLs from the output of object_retrieval.

Conclusion

The **rscopus** package provides an interface to the Scopus API through R. The package allows users to retrieve information about authors, individual articles, or institutions from the API. The information that can be obtained is limited by the scopes enabled by the API key through Elsevier and the associated organization. We have shown how to obtain an API key and specific use cases, which we believe covers the a number of the needs of the users.

More advanced usage requires additional information about the Scopus API and its querying specifications. The future direction of this package is to create helper functions to construct queries for more targeted views of the data. Additional APIs from Elsevier have functions for access, such as SciDirect with the rscopus::sciencedirect_search function, but the main focus of the package has been Scopus. Although the goal is to keep all functionality up to date with the number of APIs, the main focus will be consistency and stability with respect to Scopus.

Supplemental Material

Here is the simple parser unique_title to find the first 3 relevant words of the title after removing non-relevant words froma list in the **stopwords** package (Benoit et al., 2017):

```
unique_title = function(x) {
  ss = sapply(strsplit(x, split = " "),
              function(x) {
                x = x[ !tolower(x) %in% stopwords::stopwords()]
                x = x[ !x %in% c("-", "?", "--", 1:100)]
                paste(x[1:3], collapse = " ")
              })
  stopifnot(length(unique(ss)) == length(unique(x)))
  ss
}
```

Bibliography

M. Aria and C. Cuccurullo. bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4):959–975, 2017. URL `https://doi.org/10.1016/j.joi.2017.08.007`. [p1]

K. Benoit, D. Muhr, and K. Watanabe. *stopwords: Multilingual Stopword Lists*, 2017. URL `https://CRAN.R-project.org/package=stopwords`. R package version 0.9.0. [p12]

L. Egghe. Theory and practise of the g-index. *Scientometrics*, 69(1):131–152, 2006. [p6]

L. Henry and H. Wickham. *purrr: Functional Programming Tools*, 2018. URL `https://CRAN.R-project.org/package=purrr`. R package version 0.2.5. [p8]

J. E. Hirsch. An index to quantify an individual's scientific research output. *Proceedings of the National academy of Sciences*, 102(46):16569–16572, 2005. [p5]

J. Keirstead. *scholar: analyse citation data from Google Scholar*, 2016. URL `http://github.com/jkeirstead/scholar`. R package version 0.1.5. [p1]

J. Muschelli. *gcite: Google Citation Parser*, 2018. URL `https://CRAN.R-project.org/package=gcite`. R package version 0.9.2. [p1]

H. Wickham. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York, 2016. ISBN 978-3-319-24277-4. URL `http://ggplot2.org`. [p5]

H. Wickham. *httr: Tools for Working with URLs and HTTP*, 2017. URL `https://CRAN.R-project.org/package=httr`. R package version 1.3.1. [p6]

H. Wickham and L. Henry. *tidyr: Easily Tidy Data with 'spread()' and 'gather()' Functions*, 2018. URL `https://CRAN.R-project.org/package=tidyr`. R package version 0.8.1. [p9]

H. Wickham, R. François, L. Henry, and K. Müller. *dplyr: A Grammar of Data Manipulation*, 2018. URL `https://CRAN.R-project.org/package=dplyr`. R package version 0.7.7. [p5]

H. Wickham et al. Tidy data. *Journal of Statistical Software*, 59(10):1–23, 2014. [p8]

John Muschelli
Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health
615 N Wolfe St Baltimore, MD 21205
`jmuschel@jhsph.edu`