

R Notebook

This is R code from Modern Data Science with R, Chapter 15 Text as data.

In Section 15.2 Analyzing textual data there is an example where research papers related to Data Science are downloaded from aRxiv and summarized.

```
library(tidyverse)
```

```
## -- Attaching packages ----- tidyverse 1
## v ggplot2 3.1.0      v purrr  0.2.5
## v tibble  1.4.2      v dplyr  0.7.7
## v tidyr   0.8.2      v stringr 1.3.1
## v readr   1.1.1      v forcats 0.3.0

## -- Conflicts ----- tidyverse_conflic
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(mdsr)
```

```
## Loading required package: lattice
## Loading required package: ggformula
## Loading required package: ggstance
##
## Attaching package: 'ggstance'

## The following objects are masked from 'package:ggplot2':
##
##   geom_errorbarh, GeomErrorbarh
##
## New to ggformula? Try the tutorials:
##   learnr::run_tutorial("introduction", package = "ggformula")
##   learnr::run_tutorial("refining", package = "ggformula")

## Loading required package: mosaicData
## Loading required package: Matrix
##
## Attaching package: 'Matrix'

## The following object is masked from 'package:tidyr':
##
##   expand

## The 'mosaic' package masks several functions from core packages in order to add
## additional features. The original behavior of these functions should not be affected by this.
##
## Note: If you use the Matrix package, be sure to load it BEFORE loading mosaic.
##
## In accordance with CRAN policy, the 'mdsr' package
##   no longer attaches
## the 'tidyverse' package automatically.
```

```
## You may need to 'library(tidyverse)' in order to
## use certain functions.
```

```
library(arXiv)
```

```
DataSciencePapers <- arxiv_search(query = "Data Science", limit = 200)
```

```
## retrieved batch 1
```

```
## retrieved batch 2
```

```
head(DataSciencePapers)
```

```
##           id           submitted           updated
## 1 astro-ph/0701361v1 2007-01-12 03:28:11 2007-01-12 03:28:11
## 2      0901.2805v1 2009-01-19 10:38:33 2009-01-19 10:38:33
## 3      0901.3118v2 2009-01-20 18:48:59 2009-01-24 19:23:47
## 4      0909.3895v1 2009-09-22 02:55:14 2009-09-22 02:55:14
## 5      1106.2503v5 2011-06-13 17:42:32 2013-06-23 21:21:41
## 6      1106.3305v1 2011-06-16 18:45:32 2011-06-16 18:45:32
##
##                                     title
## 1                                     How to Make the Dream Come True: The Astronomers' Data Manifesto
## 2 Safeguarding Old and New Journal Tables for the VO: Status for\n  Extragalactic and Radio Data
## 3                                     The CATS Service: an Astrophysical Research Tool
## 4                                     The Revolution in Astronomy Education: Data Science for the Masses
## 5                                     A Large-Scale Community Structure Analysis In Facebook
## 6                                     The Art of Data Science
##
## 1
## 2
## 3
## 4   As our capacity to study ever-expanding domains of our science has increased\n(including the tim
## 5
## 6
##
##                                     authors
## 1                                     Ray P Norris
## 2                                     Heinz Andernach
## 3                                     O. V. Verkhodanov|S. A. Trushkin|H. Andernach|V. N. Chernenkov
## 4 Kirk D. Borne|Suzanne Jacoby|K. Carney|A. Connolly|T. Eastman|M. J. Raddick|J. A. Tyson|J. Wallin
## 5                                     Emilio Ferrara
## 6                                     Matthew J. Graham
##
## 1
## 2
## 3 Special Astrophysical Observatory, Nizhnij Arkhyz, Karachaj-Cherkesia, Russia;|Special Astrophysic
## 4
## 5
## 6
##
##                                     link_abstract
## 1 http://arxiv.org/abs/astro-ph/0701361v1
## 2 http://arxiv.org/abs/0901.2805v1
## 3 http://arxiv.org/abs/0901.3118v2
## 4 http://arxiv.org/abs/0909.3895v1
## 5 http://arxiv.org/abs/1106.2503v5
## 6 http://arxiv.org/abs/1106.3305v1
##
##                                     link_pdf
```

```

## 1 http://arxiv.org/pdf/astro-ph/0701361v1
## 2     http://arxiv.org/pdf/0901.2805v1
## 3     http://arxiv.org/pdf/0901.3118v2
## 4     http://arxiv.org/pdf/0909.3895v1
## 5     http://arxiv.org/pdf/1106.2503v5
## 6     http://arxiv.org/pdf/1106.3305v1
##
##          link_doi
## 1
## 2     http://dx.doi.org/10.2481/dsj.8.41
## 3     http://dx.doi.org/10.2481/dsj.8.34
## 4
## 5     http://dx.doi.org/10.1140/epjds9
## 6 http://dx.doi.org/10.1007/978-1-4614-3323-1_4
##
## 1
## 2
## 3 8 pages, no figures; accepted for publication in Data Science Journal, vol. 8 (2009), http://ds.
## 4
## 5
## 6
##
##          journal_ref          doi primary_category
## 1
## 2          10.2481/dsj.8.41      astro-ph.IM
## 3          10.2481/dsj.8.34      astro-ph.IM
## 4
## 5 EPJ Data Science, 1:9, 2012    10.1140/epjds9      cs.SI
## 6          10.1007/978-1-4614-3323-1_4  astro-ph.IM
##
##          categories
## 1          astro-ph
## 2          astro-ph.IM|astro-ph.CO
## 3          astro-ph.IM|astro-ph.CO
## 4          astro-ph.IM|cs.DB|cs.DL|cs.IR|physics.ed-ph
## 5 cs.SI|cs.CY|physics.soc-ph|91D30, 05C82, 68R10, 90B10, 90C35|H.2.8; D.2.8
## 6          astro-ph.IM|cs.DL

```

```
library(lubridate)
```

```

##
## Attaching package: 'lubridate'

## The following object is masked from 'package:base':
##
##     date

```

```

DataSciencePapers <- DataSciencePapers %>%
  mutate(submitted = ymd_hms(submitted), updated = ymd_hms(updated))
glimpse(DataSciencePapers)

```

```

## Observations: 200
## Variables: 15
## $ id          <chr> "astro-ph/0701361v1", "0901.2805v1", "0901.31...
## $ submitted   <dtm> 2007-01-12 03:28:11, 2009-01-19 10:38:33, 20...
## $ updated     <dtm> 2007-01-12 03:28:11, 2009-01-19 10:38:33, 20...
## $ title       <chr> "How to Make the Dream Come True: The Astrono...
## $ abstract    <chr> " Astronomy is one of the most data-intensiv...
## $ authors     <chr> "Ray P Norris", "Heinz Andernach", "O. V. Ver...

```

```
## $ affiliations <chr> "", "", "Special Astrophysical Observatory, N...
## $ link_abstract <chr> "http://arxiv.org/abs/astro-ph/0701361v1", "h...
## $ link_pdf <chr> "http://arxiv.org/pdf/astro-ph/0701361v1", "h...
## $ link_doi <chr> "", "http://dx.doi.org/10.2481/dsj.8.41", "ht...
## $ comment <chr> "Submitted to Data Science Journal Presented ...
## $ journal_ref <chr> "", "", "", "", "EPJ Data Science, 1:9, 2012"...
## $ doi <chr> "", "10.2481/dsj.8.41", "10.2481/dsj.8.34", "...
## $ primary_category <chr> "astro-ph", "astro-ph.IM", "astro-ph.IM", "as...
## $ categories <chr> "astro-ph", "astro-ph.IM|astro-ph.CO", "astro..."
```

```
tally(~ year(submitted), data = DataSciencePapers)
```

```
## year(submitted)
## 2007 2009 2011 2012 2013 2014 2015 2016 2017
## 1 3 3 7 12 25 52 89 8
```

```
DataSciencePapers %>% filter(year(submitted) == 2007) %>%
  glimpse()
```

```
## Observations: 1
## Variables: 15
## $ id <chr> "astro-ph/0701361v1"
## $ submitted <dtm> 2007-01-12 03:28:11
## $ updated <dtm> 2007-01-12 03:28:11
## $ title <chr> "How to Make the Dream Come True: The Astrono...
## $ abstract <chr> " Astronomy is one of the most data-intensiv...
## $ authors <chr> "Ray P Norris"
## $ affiliations <chr> ""
## $ link_abstract <chr> "http://arxiv.org/abs/astro-ph/0701361v1"
## $ link_pdf <chr> "http://arxiv.org/pdf/astro-ph/0701361v1"
## $ link_doi <chr> ""
## $ comment <chr> "Submitted to Data Science Journal Presented ...
## $ journal_ref <chr> ""
## $ doi <chr> ""
## $ primary_category <chr> "astro-ph"
## $ categories <chr> "astro-ph"
```

```
tally(~ primary_category, data = DataSciencePapers)
```

```
## primary_category
## astro-ph astro-ph.EP astro-ph.GA astro-ph.IM
## 1 1 2 8
## cond-mat.mtrl-sci cond-mat.str-el cs.AI cs.CG
## 2 1 9 1
## cs.CL cs.CR cs.CV cs.CY
## 2 1 2 25
## cs.DB cs.DC cs.DL cs.DS
## 11 5 3 4
## cs.ET cs.GT cs.HC cs.IR
## 1 3 3 3
## cs.IT cs.LG cs.NA cs.NE
## 2 13 1 2
## cs.NI cs.OH cs.PL cs.RO
## 1 2 2 1
## cs.SE cs.SI gr-qc math.AT
## 2 15 1 2
```

```
##          math.CO          math.HO          math.OC          math.PR
##           1             1             4             3
##          math.ST  physics.chem-ph  physics.comp-ph  physics.data-an
##           8             1             1             2
##          physics.ed-ph  physics.geo-ph  physics.soc-ph          q-bio.GN
##           1             1             16            1
##          q-bio.PE          q-fin.EC          q-fin.GN          q-fin.ST
##           1             1             1             1
##          stat.AP          stat.CO          stat.ME          stat.ML
##           7             4             2             4
##          stat.OT
##           7
```

```
DataSciencePapers %>% mutate(field = str_extract(primary_category, "[a-z,-]+")) %>%
  tally(x = ~field) %>%
  sort()
```

```
## field
##   gr-qc  q-bio cond-mat  q-fin astro-ph  math  physics  stat
##     1     2     3       3     12     19     22     24
##    cs
##   114
```

Now using the *tm* package to convert the data.frame to a corpus.

```
library(tm)
```

```
## Loading required package: NLP
##
## Attaching package: 'NLP'
## The following object is masked from 'package:ggplot2':
##
##   annotate
##
## Attaching package: 'tm'
## The following object is masked from 'package:mosaic':
##
##   inspect
```

```
Corpus <- with(DataSciencePapers, VCorpus(VectorSource(abstract)))
Corpus[[1]] %>% as.character() %>%
  strwrap()
```

```
## [1] "Astronomy is one of the most data-intensive of the sciences. Data"
## [2] "technology is accelerating the quality and effectiveness of its"
## [3] "research, and the rate of astronomical discovery is higher than"
## [4] "ever. As a result, many view astronomy as being in a 'Golden Age',"
## [5] "and projects such as the Virtual Observatory are amongst the most"
## [6] "ambitious data projects in any field of science. But these"
## [7] "powerful tools will be impotent unless the data on which they"
## [8] "operate are of matching quality. Astronomy, like other fields of"
## [9] "science, therefore needs to establish and agree on a set of"
## [10] "guiding principles for the management of astronomical data. To"
## [11] "focus this process, we are constructing a 'data manifesto', which"
## [12] "proposes guidelines to maximise the rate and cost-effectiveness of"
```

```
## [13] "scientific discovery."
Corpus <- Corpus %>% tm_map(stripWhitespace) %>%
  tm_map(removeNumbers) %>%
  tm_map(removePunctuation) %>%
  tm_map(content_transformer(tolower)) %>%
  tm_map(removeWords, stopwords("english"))
strwrap(as.character(Corpus[[1]]))
```

```
## [1] "astronomy one dataintensive sciences data technology accelerating"
## [2] "quality effectiveness research rate astronomical discovery higher"
## [3] "ever result many view astronomy golden age projects virtual"
## [4] "observatory amongst ambitious data projects field science powerful"
## [5] "tools will impotent unless data operate matching quality astronomy"
## [6] "like fields science therefore needs establish agree set guiding"
## [7] "principles management astronomical data focus process constructing"
## [8] "data manifesto proposes guidelines maximise rate costeffectiveness"
## [9] "scientific discovery"
```

Now using the *wordcloud* package visualize the data. Do you see Data Science?

```
library(wordcloud)
```

```
## Loading required package: RColorBrewer
```

```
wordcloud(Corpus, max.words = 30, scale = c(8, 1), colors = topo.colors(n = 30), random.color = TRUE)
```



Create a Document Term Matrix using tf-idf.

```
DTM <- DocumentTermMatrix(Corpus, control = list(weighting = weightTfIdf))
DTM
```

```
## <<DocumentTermMatrix (documents: 200, terms: 5198)>>
## Non-/sparse entries: 16015/1023585
## Sparsity : 98%
## Maximal term length: 29
## Weighting : term frequency - inverse document frequency (normalized) (tf-idf)
```

```
findFreqTerms(DTM, lowfreq = 0.8)
```

```
## [1] "algorithm" "algorithms" "also" "analysis"
## [5] "applications" "approach" "approaches" "article"
## [9] "available" "based" "big" "can"
## [13] "challenges" "classification" "complex" "computing"
## [17] "course" "data" "dataset" "datasets"
## [21] "describe" "design" "different" "discovery"
## [25] "discuss" "features" "find" "first"
## [29] "framework" "graph" "historical" "however"
## [33] "hypergraphs" "identify" "important" "information"
## [37] "knowledge" "language" "large" "learning"
## [41] "machine" "management" "many" "matrix"
## [45] "method" "methods" "model" "models"
## [49] "modern" "network" "networks" "new"
## [53] "novel" "number" "one" "online"
## [57] "optimization" "paper" "patterns" "people"
## [61] "performance" "perspective" "present" "problem"
## [65] "problems" "process" "properties" "provide"
## [69] "provides" "representation" "research" "results"
## [73] "review" "role" "science" "sciences"
## [77] "scientific" "set" "sets" "show"
## [81] "social" "statistical" "statistics" "structure"
## [85] "students" "study" "support" "system"
## [89] "systems" "techniques" "time" "tools"
## [93] "traffic" "two" "use" "used"
## [97] "users" "using" "various" "well"
## [101] "wikipedia" "will" "work"
```

```
DTM %>% as.matrix() %>%
  apply(MARGIN = 2, sum) %>%
  sort(decreasing = TRUE) %>%
  head(9)
```

```
##          big      model  research      models      science      social
## 1.889224 1.836078 1.701455 1.659216 1.639938 1.637129
## learning statistical information
## 1.601776 1.585974 1.574497
```

```
findAssocs(DTM, terms = "statistics", corlimit = 0.5)
```

```
## $statistics
##      courses undergraduate introductory      students      appearing
##      0.64          0.63          0.56          0.55          0.53
##      irrelevant      judge      somehow      todays      inspiration
##      0.53          0.53          0.53          0.51          0.50
##      standalone
##      0.50
```

```
findAssocs(DTM, terms = "mathematics", corlimit = 0.5)
```

```
## $mathematics
## conceptual light historical perspective review role
## 0.99 0.98 0.95 0.95 0.94 0.84
## modern
## 0.81
```