MET CS688 C1

WEB ANALYTICS AND MINING

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WEB MINING

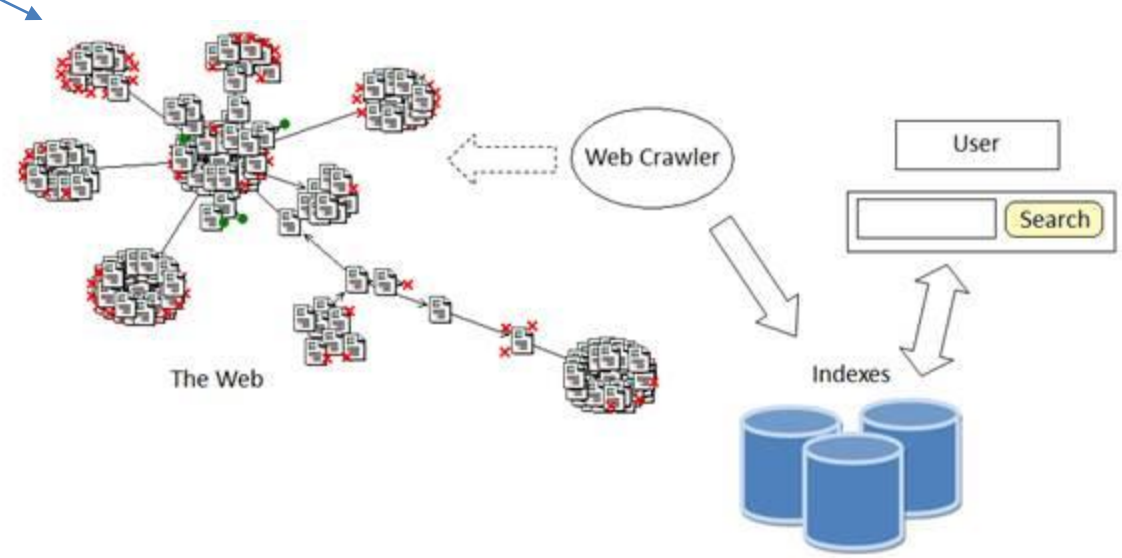
Web Mining

- Similar techniques to text mining
  - Difference, in the use of a search engine (the information data is on the web)
- Gathering pages from the web and indexing them in order to support a search engine.
- Web mining technology applies to mining data in a variety of form such as:
  - Web pages
  - A collection of SGML (Standard Generalized Markup Language) generalized markup language for documents
  - XML (Extensible Markup Language) documents, textual data format intended to be both human and machine readable.
  - Genome databases (for example GenBank, PIR)
  - Online dictionary (for example Oxford English Dictionary)
  - Emails or plain texts on a file system.

Components of a web search engine

- The techniques for web mining are similar to the ones used for text mining with the exception of the use of a search engine.

- The search engine has the following architecture
  - Content Aggregator (Crawling Subsystem, Google, Yahoo etc. search)
  - Indexing Subsystem
  - Search Interface
  - User (Content Consumer)



What is Web Mining?

Discovering information we need from the World-Wide Web.

- Textual information and web links structure
- Data generated per day is comparable to largest conventional data warehouses
- Often need to react to evolving usage patterns in real-time

Size of the Web

Number of pages – ”infinitely” large.

- Although much of it is duplication (30-40%)
- Best estimate of “unique” static HTML pages comes from search engine claims.
- Google claimed and Yahoo claimed tens of billion.
- Google recently announced that their index contains 1 trillion pages.

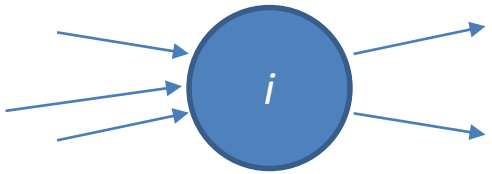
The web as a graph

- Directed graph
  - Pages - nodes,
  - hyperlinks - edges

- High linkage 10-20 links/page on average
  - The links between the web pages are not randomly distributed
  - Power-law degree distribution (see Module 4 Discussion)

Power-law degree distribution

- Assigning properties to the edges of a graph, such as a web page endorsements turns the graph into a network.
- The empirical study of networks has played an important role from biological and social to telecommunication, computer and web networks.
- In the case of the Web, the links between the web pages are not randomly distributed.
- They follow a power law distribution based on the in-node degree (*i*).

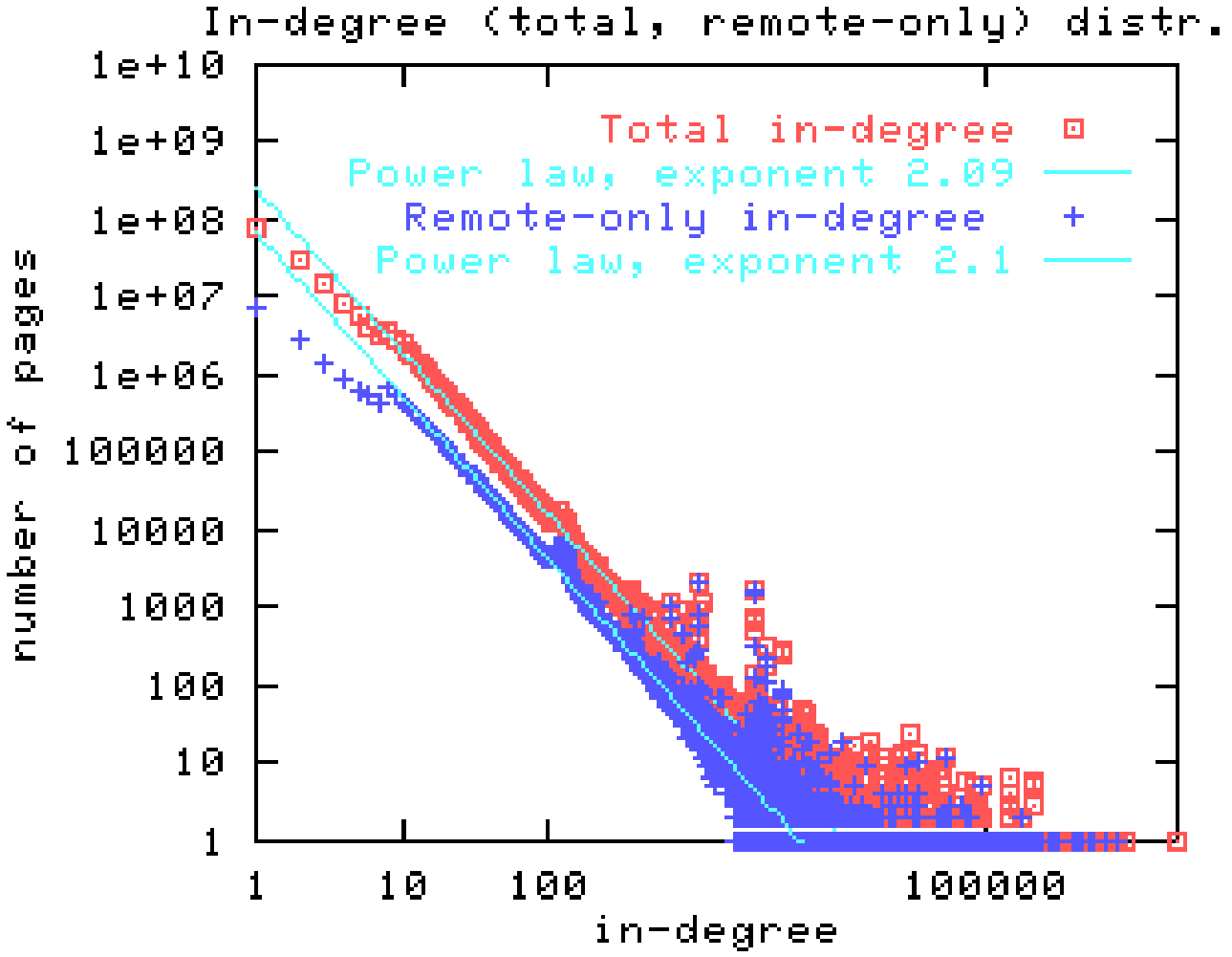


- The total number of web pages with in-degree *i*, almost as a natural law, is proportional to $i^{-\beta}$, where $\beta \approx 2.1$, strongly indicating some aspects about the spontaneous association structure of the Web.

Power-law degree distribution

- The total number of web pages vs. in-degree *i*

- Source: Broder et al, 2000



Approaches to Analyzing Data

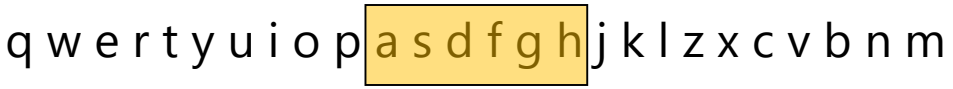
1. Machine Learning approach
   - Using sophisticated algorithms that require relatively long processing time
   - Data sets need to be relatively small, to avoid memory and speed issues.

2. Data Mining approach
   - Convenient for big data sets
   - Data size and processing speed forces the use of simpler algorithms.

- In many cases, adding more data leads to better results than improving algorithms but up to some point.

Sliding Windows Big Data Example

Model of stream processing



- queries refer to a window of length N (the N=6 most recent elements received)

Big Data model extension (lots of online retailer examples)

- N is so large that the data cannot be stored in memory, or even on a disk.
- There are so many streams that windows for all cannot be stored

“Alphabet” Simplification

- Use binary stream (1 - for product sold in the n-th transaction)
- Query - how many sold items in a window of sales.

Sliding Windows Big Data Example

0 1 0 0 1 1 0 1 1 1 0 1 0 1 0 1 1 0 1 1 0 1 1 0

- For a small window of length N=6 we can store the most recent N bits.
- For a "big data" window we cannot do this, for example N=1billion.

Note: We **can not** get an exact answer without storing the entire window!

- But if approximate answer is acceptable we can use several simple algorithms.
- For example keep moving average of "0" and "1".
  - **Question**: How many 1's are in the last N bits?
  - **Question**: What are the assumptions on the streaming of "0" and "1" in this approach?

Simple Web Pages Analysis in R

- After the crawl, the saved web pages can be analyzed for content.
- Example below illustrates how the R code is used
  - To strip the table data from the HTML files.
  - Assumes the data was saved at location specified by object "dir".

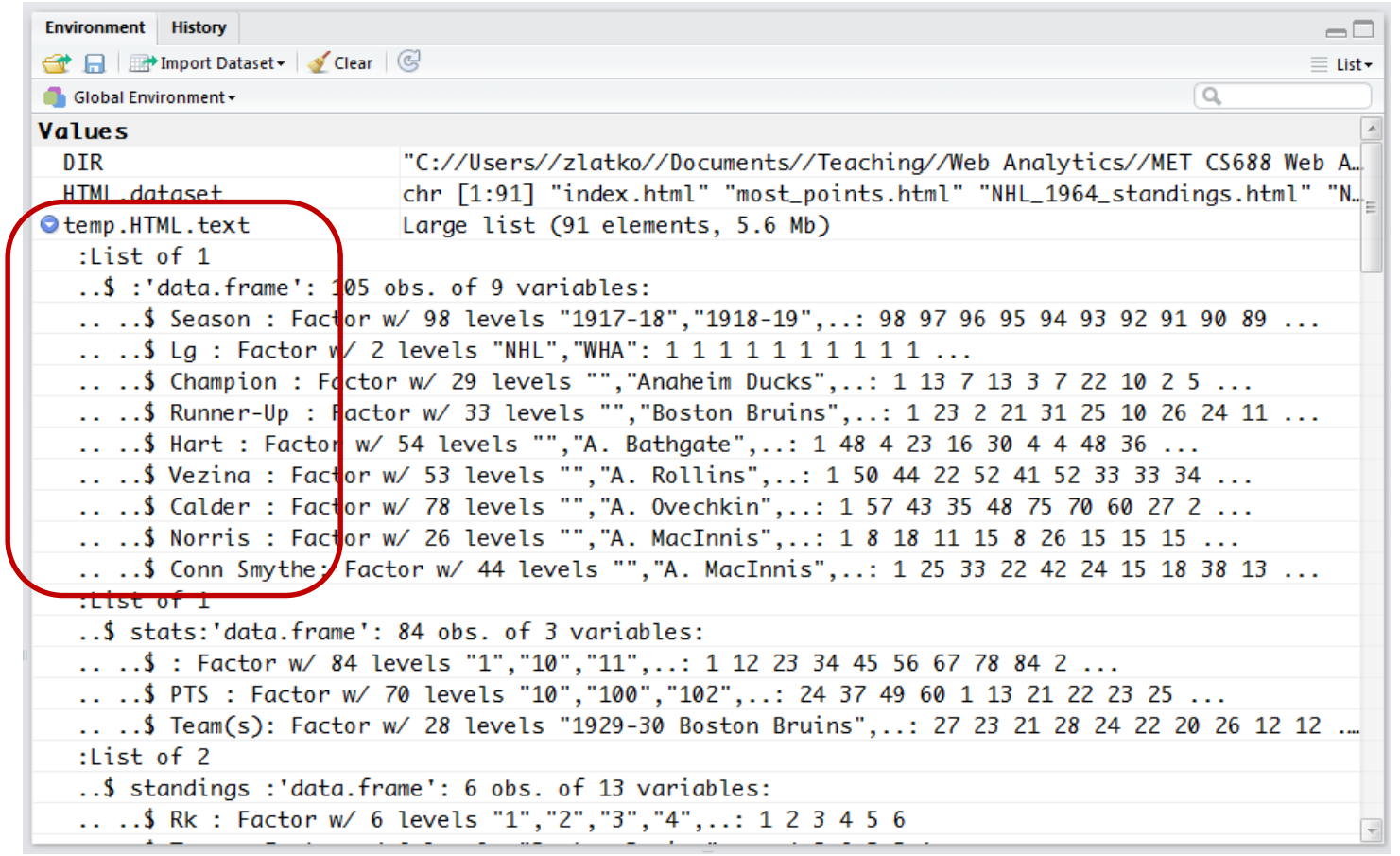
```
# Example: Analyze WebSPHINX results
library(XML)
HTML.dataset <- list.files(dir,pattern ="html") # List of all saved HTML files @ location "dir"

# Function to strip the table data from the HTML files
sieve.HTML <- function(URL) {
  table <- readHTMLTable(URL) # Read HTML table into a list
}
temp.HTML.text <- lapply(HTML.dataset,function(x) sieve.HTML(x)) # Get all the text from the saved HTMLs
```

  - HTML.dataset contains the names of all of the crawled and saved web pages.
  - For each saved HTML file the function sieve.HTML() is called through lapply().

Simple Web Pages Analysis in R

- The object temp.HTML.text is a list of many (in this case 91) data tables.
- For the Index.html page (the first data frame in the object temp.HTML.text) You can see the column names and access the data for example in the “Seasons” column as:

  temp.HTML.text[[1]][[1]]$Season



Simple Web Pages Analysis in R

- The first (*index.html*) file contains the list of all of the NHL champions since 1917
- Note the column titles in the *index.html* page. The third is “Champions”
- You can check that in the data table object temp.HTML.text also.

```
temp.HTML.text[[1]][[1]]
```

- If we search for "Boston Bruins" the column “Champions”

```
> query <- "Boston Bruins"
> temp <- grep(query, temp.HTML.text[[1]][[1]]$Champion)
[1]  5 51 53 82 84 94
```

- We get the indices where the query appears
- As an example we can get the corresponding seasons when the Bruins were champions.

```
temp.HTML.text[[1]][[1]]$Season[temp]
2010-11
1971-72
1969-70
1940-41
1938-39
1928-29
```

League Index

Click on the **Season** or **Lg** for league statistics,
Click on the **Champion** or **Runner-up** for team
Click on the **Trophy Winners** for career statist

Season	Lg	Champion	Runner-Up
2015-16	NHL		
2014-15	NHL	Chicago Blackhawks	Tampa Bay Lightning
2013-14	NHL	Los Angeles Kings	New York Rangers
2012-13	NHL	Chicago Blackhawks	Boston Bruins
2011-12	NHL	Los Angeles Kings	New Jersey Devils
2010-11	NHL	Boston Bruins	Vancouver Canucks
2009-10	NHL	Chicago Blackhawks	Philadelphia Flyers
2008-09	NHL	Pittsburgh Penguins	Detroit Red Wings
2007-08	NHL	Detroit Red Wings	Pittsburgh Penguins
2006-07	NHL	Anaheim Ducks	Ottawa Senators
2005-06	NHL	Carolina Hurricanes	Edmonton Oilers
2004-05	NHL	*Season canceled*	

About EDGAR

EDGAR, the Electronic Data Gathering, Analysis, and Retrieval system, performs automated collection, validation, indexing, acceptance, and forwarding of submissions by companies and others who are required by law to file forms with the U.S. Securities and Exchange Commission (the "SEC"). The database is freely available to the public via the Internet (Web or FTP).

Visit : http://www.sec.gov/cgi-bin/browse-edgar?company=frontline&owner=exclude&action=getcompany

Example: Retrieving Financial Data from EDGAR.

1. Familiarize yourself with the HTML structure of the site and the relevant pages you would like to scrape.
2. Use library(rvest)
3. Form a query: SearchQuery <- "frontline“
4. Use string concatenation (paste0()) to form the above link with SearchQuery instead of frontline
5. Create a user defined function to strip the data from the URL
   you can use some of “rvest” functions such as “read_html()”, “html_nodes()”, “html_text()”
6. If needed, call the user defined function with lapply()

Note: Scraping web pages requires great deal of programming skils.

Scraping Financial Data from EDGAR

EDGAR stands for the Electronic Data Gathering, Analysis, and Retrieval system. It is a US. Securities and Exchange Commission website.

http://www.sec.gov/edgar/searchedgar/companysearch.html

This website performs automated collection, validation, indexing, acceptance, and forwarding of submissions by companies and others who are required by law to file forms with the U.S. Securities and Exchange Commission (the "SEC"). ").

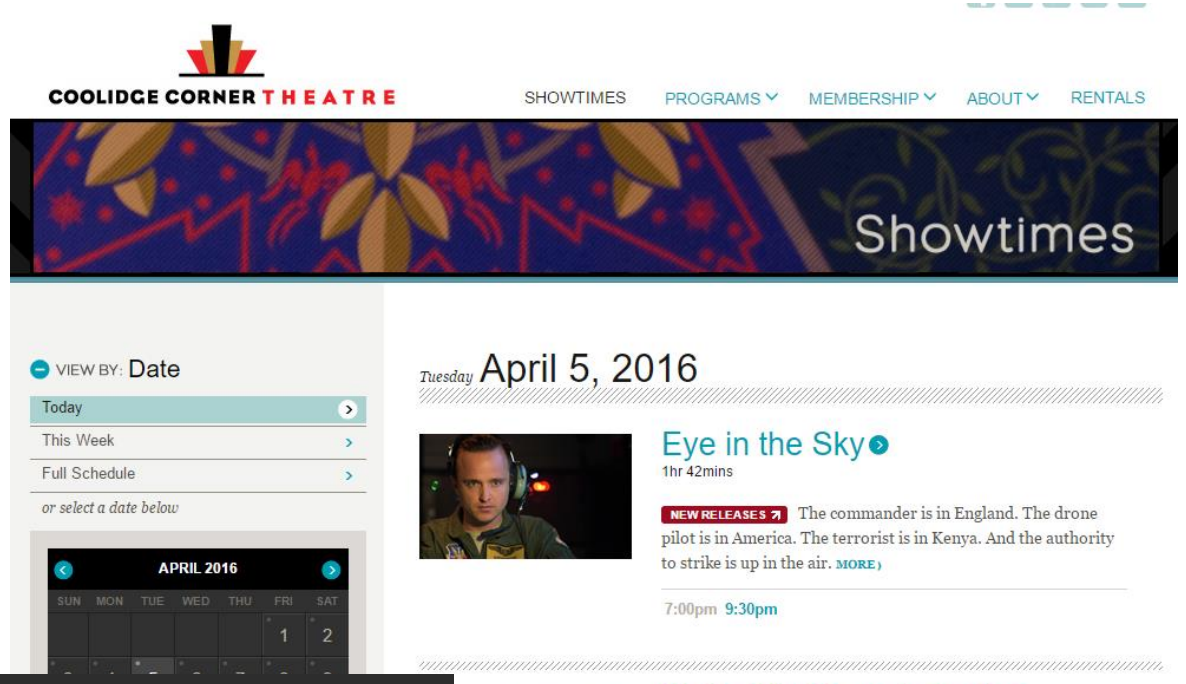
The database is freely available to the public via the Internet (Web or FTP). There are Other countries' equivalents to EDGAR such as SEDAR in Canada for example or Companies House, United Kingdom.

See posted code examples using the package “edgarWebR”.

Note: Scraping web pages requires great deal of programming skills.

Retrieving Movie Showtimes

- Another relatively simple example of webpage (HTML) content scraping.
- Note how the relevant tags need to be addressed.
- It assumes familiarity to the page structure.




```
47 ### --- Example 3: Access Current Movies Showtimes. --------
48 library("rvest")
49 movies <- read_html("http://www.coolidge.org/showtimes/")
50 titles <- html_nodes(movies,
51                      "#view-id-external_showtime_date_browser-page div.film-event-title")
52 html_text(titles) # Display Current Movies
53 # [1] "Eye in the Sky "          "Hello, My Name is Doris " "Midnight Special "        "The Clan "
54
```

Accessing/Modifying Information in XML Files

- The XML file is a standard way of keeping information for many professional applications.
- Note the module 4 code contains the commented XML used there.
- You need to uncomment the XML part and save it as an XML file.

```r
### --- Example 4: Access XML File. --------
## sequencing.xml file content
# <data>
#   <sequence id = "ancestralSequence">
#   <taxon id="test1">Taxon1
# </taxon>
#   GCAGTTGACACCCTT
# </sequence>
#   <sequence id = "currentSequence">
#   <taxon id="test2">Taxon2
# </taxon>
#   GACGGCGCGGAccAG
# </sequence>
#   </data>

pth <- file.path("c:", "Users", "ZlatkoFCX","Documents","My Files","Tea
library(XML)
# read XML File located in folder "pth"
x = xmlParse(file.path(pth,"sequencing.xml"))

# returns a *list* of text nodes under "sequence" tag
nodeSet = xpathApply(x,"//sequence/text()")

# loop over the list returned, and get and modify the node value:
zz<-sapply(nodeSet,function(G){
  text = paste("Ggg",xmlValue(G),"CCaaTT",sep="")
  text = gsub("[^A-Z]","",text)
  xmlValue(G) = text
})

```

sequencing.xml

```xml
<data>
  <sequence id = "ancestralSequence">
  <taxon id="test1">Taxon1
</taxon>
  GCAGTTGACACCCTT
</sequence>
  <sequence id = "currentSequence">
  <taxon id="test2">Taxon2
</taxon>
  GACGGCGCGGACCAG
</sequence>
  </data>

```

Web sources Analysis in R

- The *tm.plugin.webmining* package is an open source framework for web mining applications.
- Facilitates the retrieval of textual data from the web.
  - In particular is implemented through WebSources (analogous to Source in "*tm*")
- Source Name:
  - GoogleBlogSearchSource http://www.google.com/blogsearch - RSS
  - GoogleFinanceSource http://www.google.com/finance - RSS
  - GoogleNewsSource http://news.google.com - RSS
  - NYTimesSource http://api.nytimes.com - JSON
  - ReutersNewsSource http://www.reuters.com/tools/rss - ATOM
  - YahooFinanceSource http://finance.yahoo.com - RSS
  - YahooInplaySource http://finance.yahoo.com/marketupdate/inplay - HTML
  - YahooNewsSource http://news.search.yahoo.com/rss - RSS

Note: To use this package you need R and Java to have matching architectures.

- For corpus construction, *tm.plugin.webmining* uses a function call
  - WebCorpus() (analogous to *tm*'s Corpus() function)
- Once obtained the Corpus can be explored using *tm*'s text mining capabilities.

Exercise: Web Mining News

- Install needed packages.
- Perofm “GoogleNewsSource“ or "YahooNewsSource" search for a user specified query.
- This is illustrated on the next few slides.

“GoogleNewsSource" example

An illustration of using the *tm.plugin.webmining* package:

1. **WebSource** downloads the meta data from the feed.
2. **WebCorpus** extracts the main content from the feed item.

- Let’s try the search for
  - **Query**: "Web Analytics“
  - **WebSource**: “GoogleNewsSource" RSS feed (or one of the listed on prev. slide)
  - Get the corpus:

```
result <- WebCorpus(GoogleNewsSource("Web Analytics"))
```

- The data feed from Google News is pre-parsed with the function GoogleNewsSource() – a WebSource object .
- WebCorpus() extracts the meta data from the WebSource object
  - downloads and extracts the actual main content of the news item (most commonly an HTML Webpage).

Performance

- Most of the time is spent downloading the main content of the corpus items.

- A more efficient and faster WebCorpus update.

```
result <- corpus.update(yahoonews)
```

- The WebCorpus can be continuously updated by setting up a scheduled task/cron job which runs corpus.update() in a script.

- For retrieval of more than 10,000 items per feed the *tm.plugin.webmining* package is not suitable and for this purpose, web scraping frameworks like Scrapy (scrapy.org), Heritrix (crawler.archive.org) or Nutch (nutch.apache.org) are much better suited.