Week 11 – Web Usage Data

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L&S 88-2

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Announcements

- Project Milestone 3: Status Update
  - Due Nov. 13th
- Assignment 2
- Thanksgiving week?

Previous lecture

- Lecture by Alberto Cairo
- Lecture by Ian and Zan from Google
- Guests' lectures evaluation

Today's lecture

- Intro to Web usage mining
- Applications of Web usage mining
- Web analytics versus Web usage mining
- Web usage data
- HTTP response codes
- Analyzing usage data

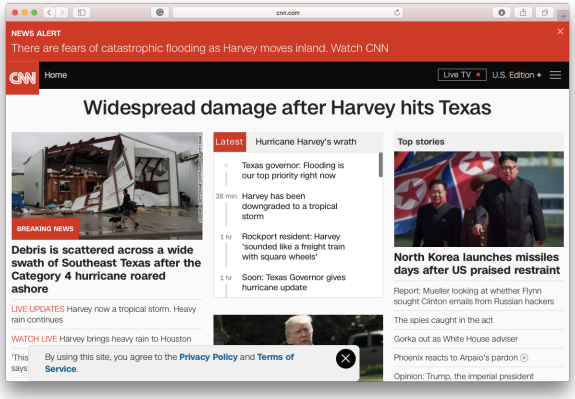
Types of Web Mining

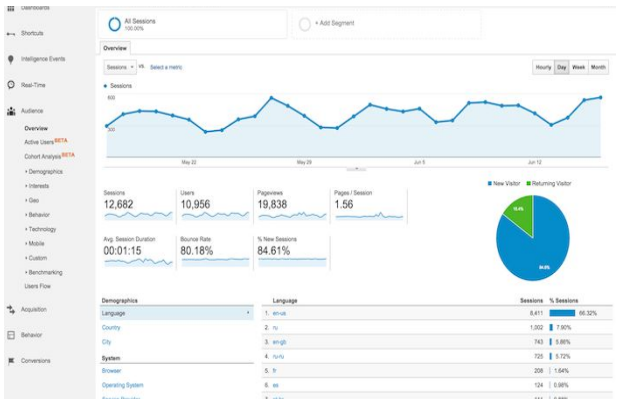
Web Mining

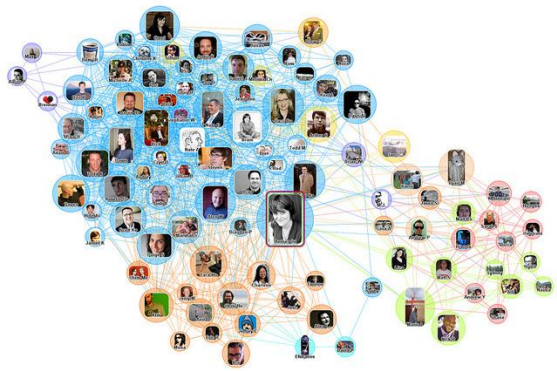
Web Content Mining

Web Usage Mining

Web Structure Mining







Types of Web Mining

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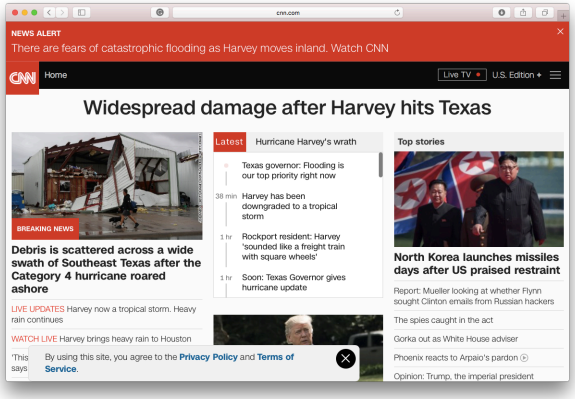
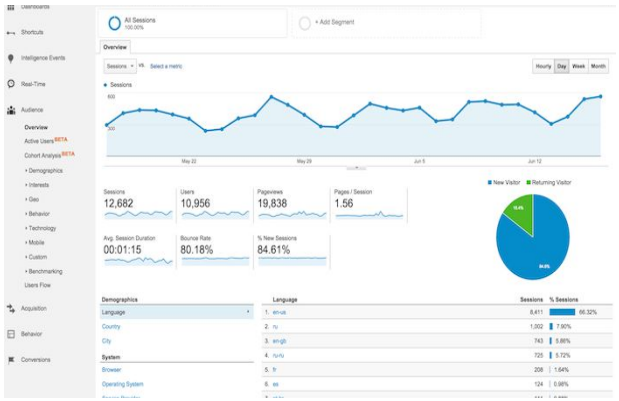
Web Content Mining



Web Usage Mining



Web Structure Mining

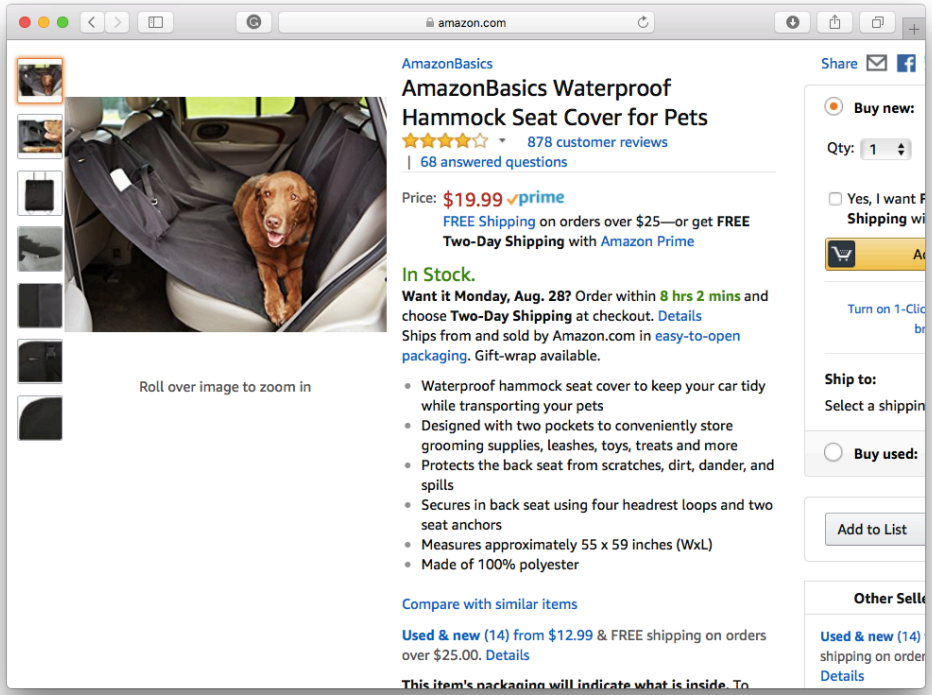
Web usage mining

- Extracting interesting patterns from user interactions with resources on one or more Web sites
- Data
  - clickstream data from Web/application server access logs
  - e-commerce and product-oriented user events (e.g., shopping cart changes, product click-throughs, purchases, etc.)
  - user profiles data, user ratings, user contributed data (tags, comments, reviews)

Applications

- User and customer behavior modeling
- Web site optimization
- E-customer relationship management
- Web marketing
- Targeted advertising
- Recommender systems

Applications



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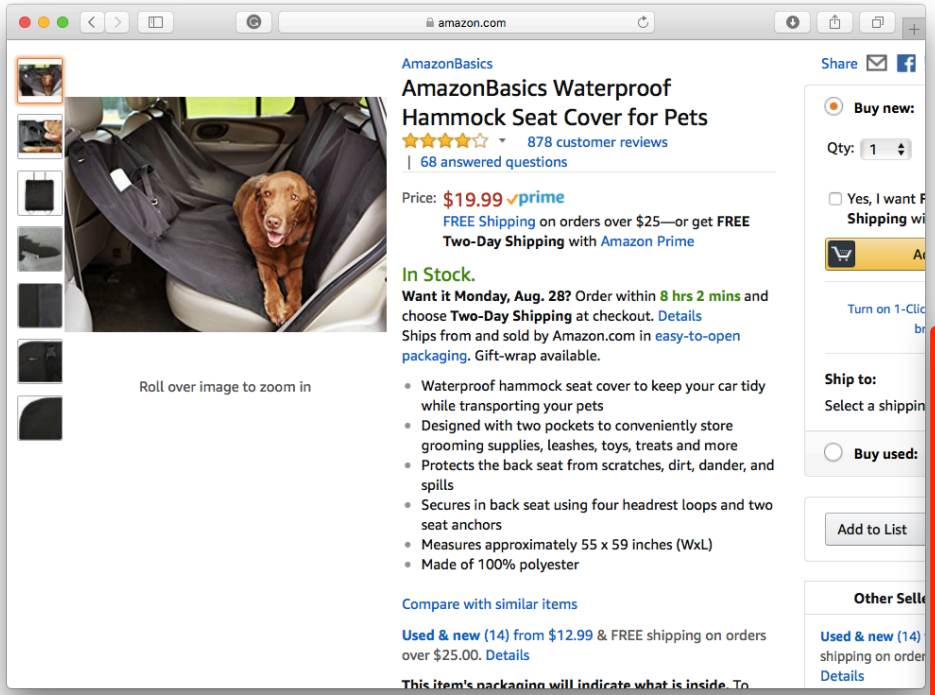
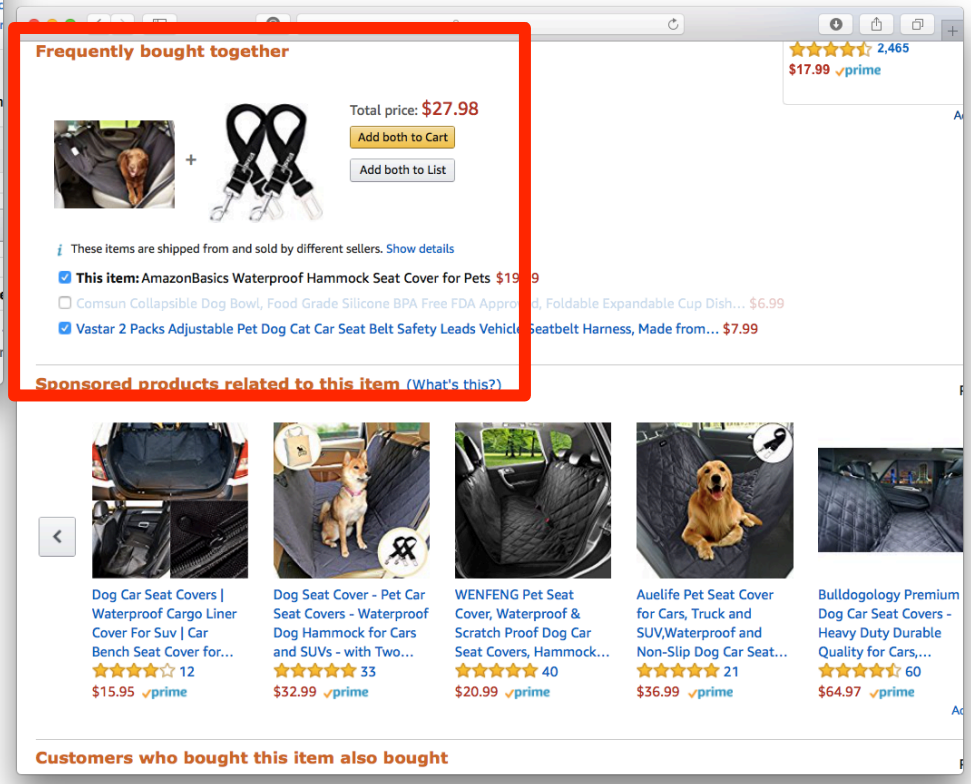
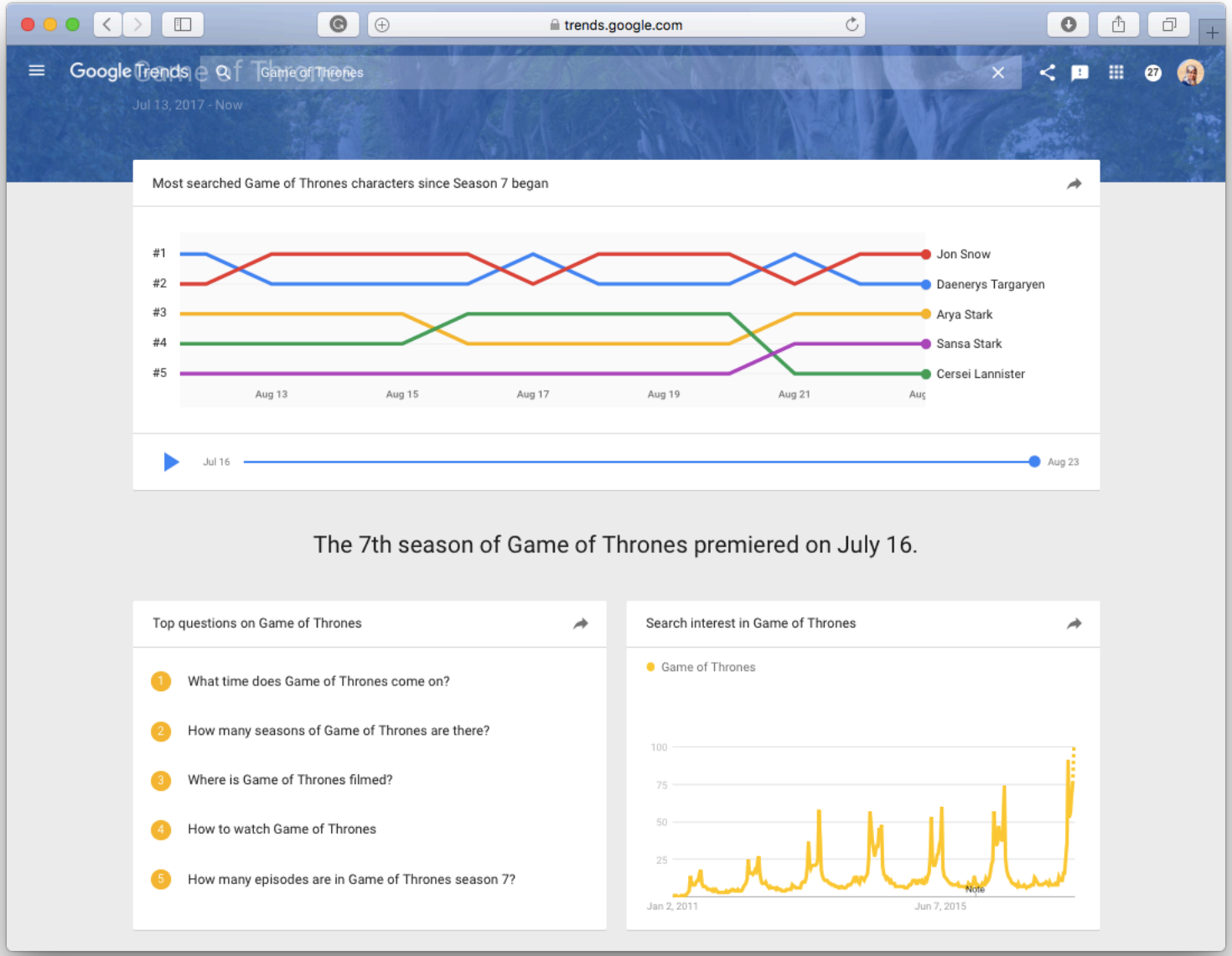




Using the Web to understand the Web

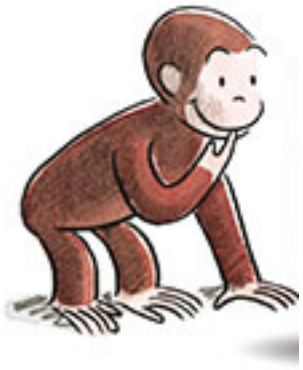


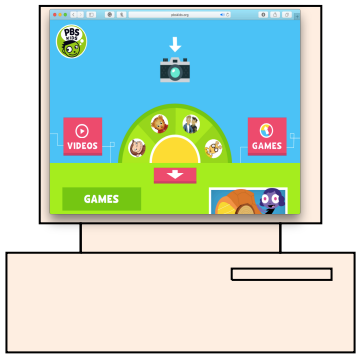
Web analytics versus Web usage mining

- Web Analytics
  - refers to the measurement, analysis, and reporting of user behavior on the Web
  - usually involves descriptive statistics from clickstream and other user behavior data at different levels of aggregations across predetermined dimensions such as time, content/product categories, referring sites, etc.
  - e.g., Google Analytics

- Web Usage Mining
  - goes beyond basic analytics to
    - discover patterns in usage data
    - identify and characterize important customer segments
    - find affinities across pages or products
    - build models to predict future behavior

How the Web works





request

Get http://pbskids.org

Web Server

Response

HTTP/1.1 200 OK

HTTP responses

- 1xx: Informational - Request received, continuing process
  - 100 Continue
- 2xx: Success - The action was successfully received, understood, and accepted
  - 200 OK
- 3xx: Redirection - Further action must be taken in order to complete the request
  - 303 Moved Temporarily
- 4xx: Client Error - The request contains bad syntax or cannot be fulfilled
  - 404 Page Not found, 403 Unauthorized
- 5xx: Server Error - The server failed to fulfill an apparently valid request
  - 501 Internal Server Error

HTTP responses
Why this is important?

- Multiple errors from assignment 2:

TweepError: Twitter error response: status code = 401

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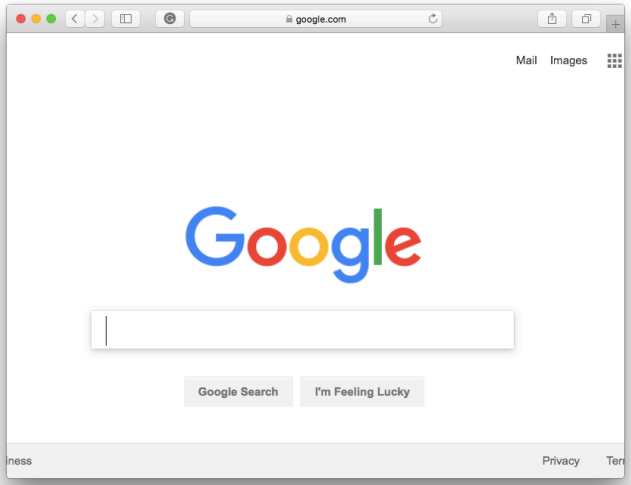

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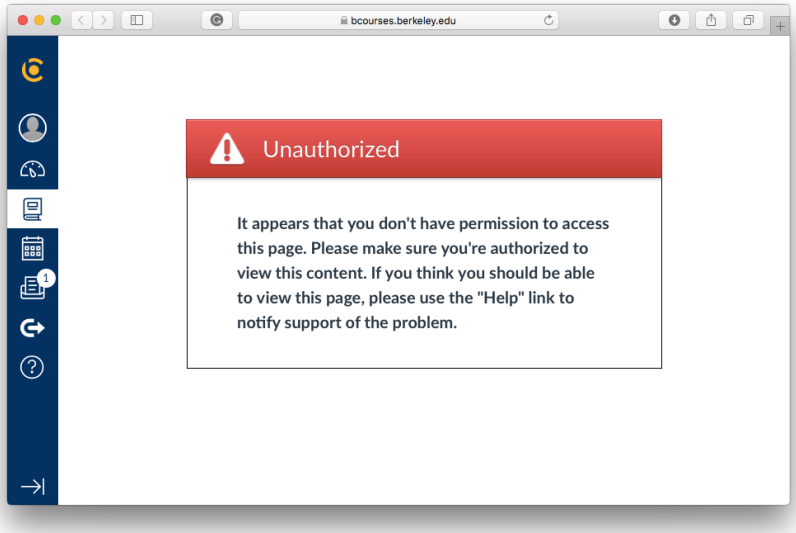

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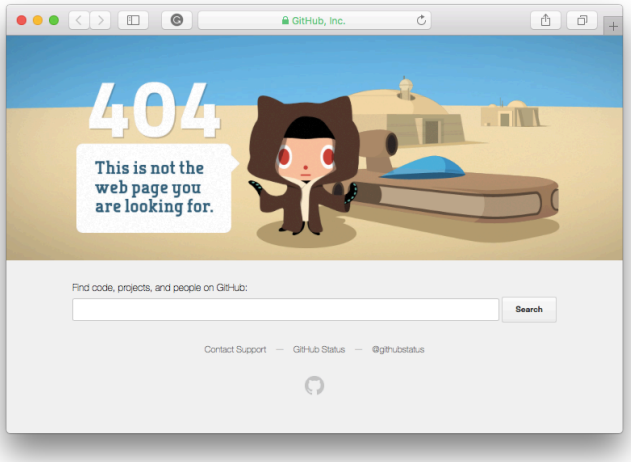

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https://i0.wp.com/s3.amazonaws.com/production-wordpress-assets/blog/wp-content/uploads/2016/11/29074529/500-internal-server-error.png?fit=604%2C237&ssl=1

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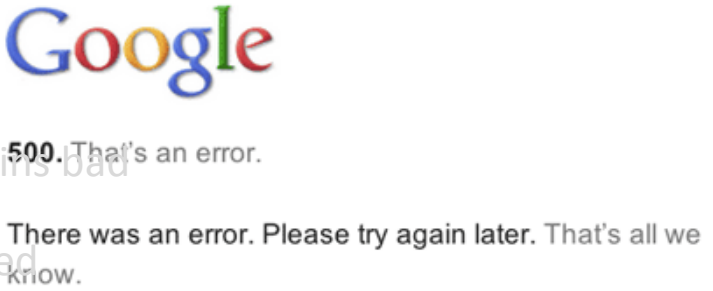

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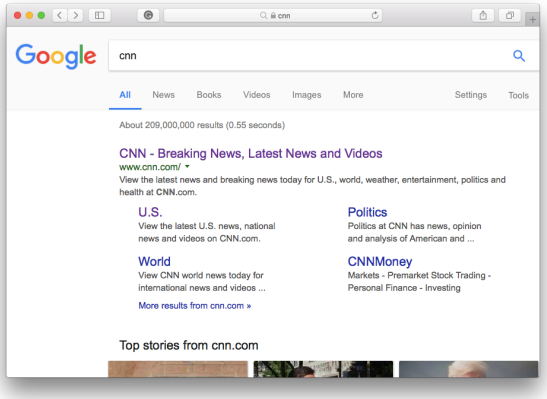
What happen when I surf the internet?

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”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7
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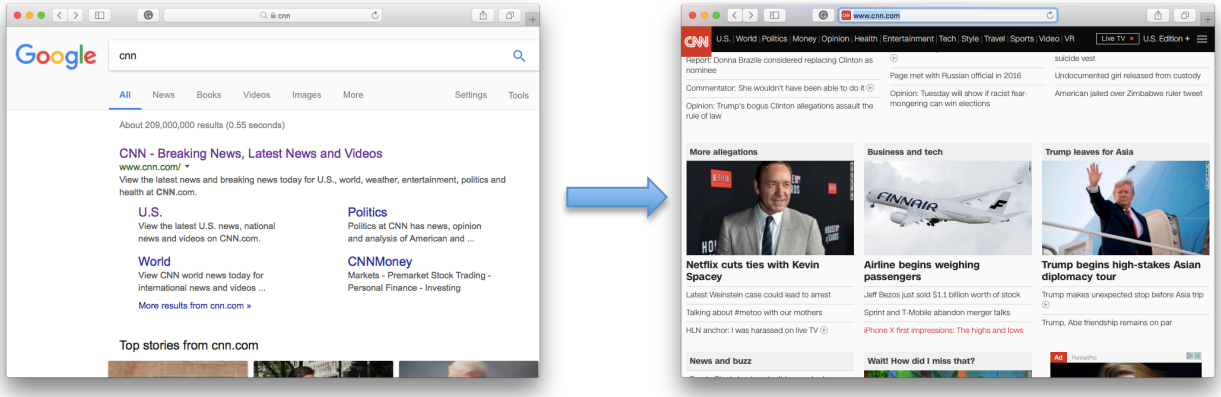


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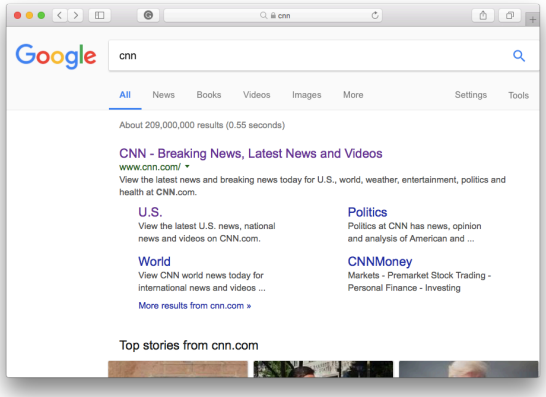

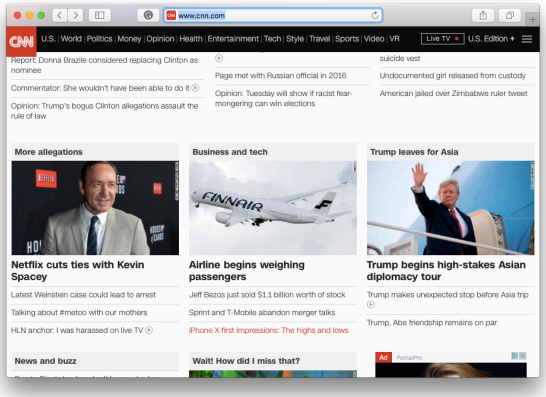

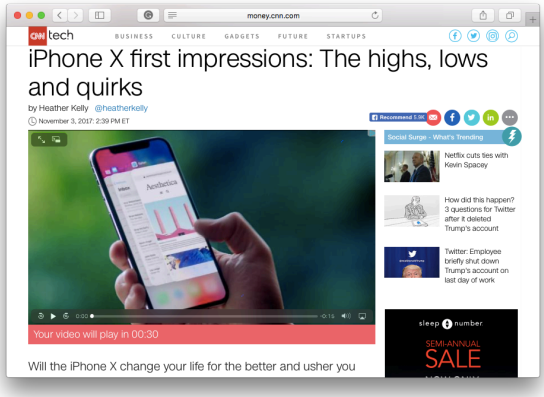


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What else do you think is recorded in log files?

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535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7”

0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://money.cnn.com/2017/10/31/technology/gadgets/iphone-x-first-impressions/index.html HTTP/1.1" 200 96433 ” http://
www.cnn.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7”
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET https://www.google.com HTTP/1.1" 200 96433 ” " "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like
Gecko) Chrome/16.0.912.77 Safari/535.7”

0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/
535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7”

0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://money.cnn.com/2017/10/31/technology/gadgets/iphone-x-first-impressions/index.html HTTP/1.1" 200 96433 ” http://
www.cnn.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7”
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET https://www.google.com HTTP/1.1" 200 96433 ” " "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like
Gecko) Chrome/16.0.912.77 Safari/535.7”
```

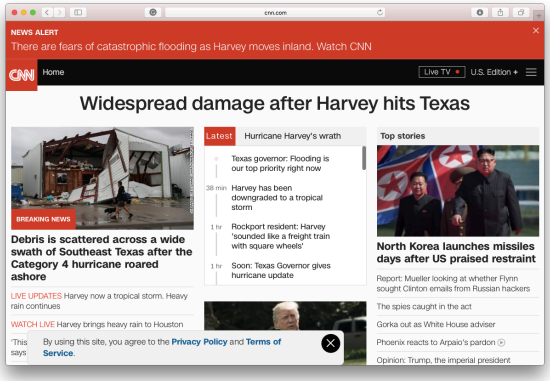
Web usage data
Server log files

- Each time a client requests a resource the server of that resource may record the following in its log files:
  - Client IP
  - Access time
  - HTTP request method
  - URI
  - Protocol
  - HTTP status code
  - Bytes sent
  - Referring URI
  - User-Agent

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"
```

- Client IP: 0.247.222.86

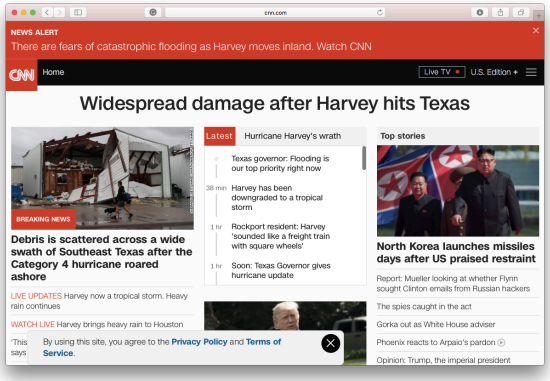


http://www.cnn.com

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/
1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac
OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77
Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000

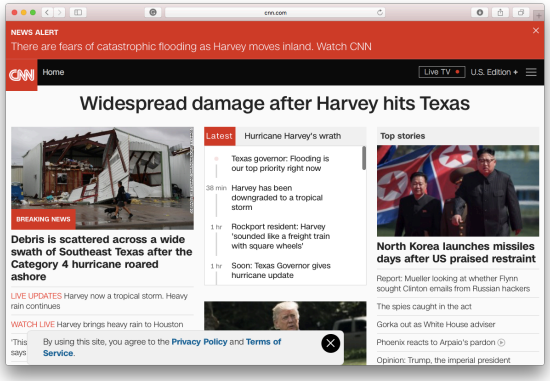


http://www.cnn.com

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/
1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac
OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77
Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000
- HTTP request method: GET

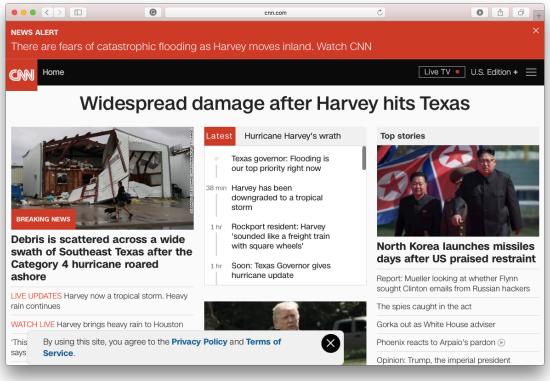


http://www.cnn.com

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/
1.1" 200 96433 "https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac
OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77
Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000
- HTTP request method: GET
- URI: http://www.cnn.com

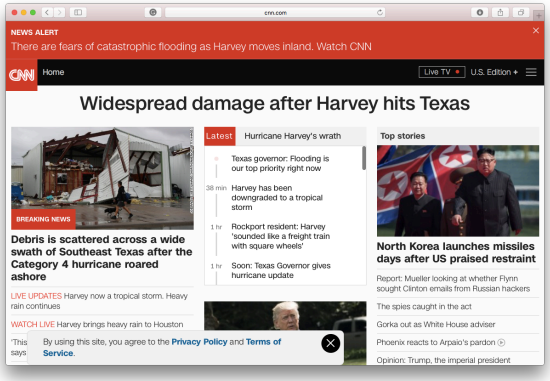


http://www.cnn.com

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000
- HTTP request method: GET
- URI: http://www.cnn.com
- Protocol: HTTP/1.1

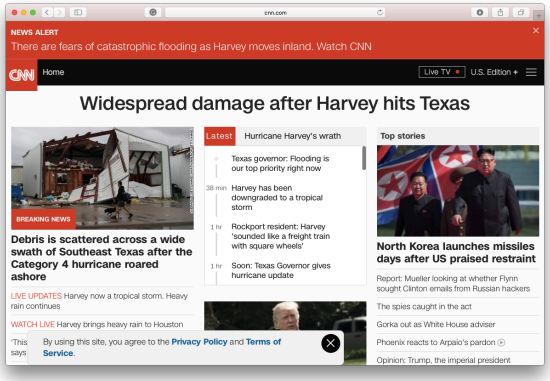


http://www.cnn.com

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000
- HTTP request method: GET
- URI: http://www.cnn.com
- Protocol: HTTP/1.1
- HTTP status code: 200

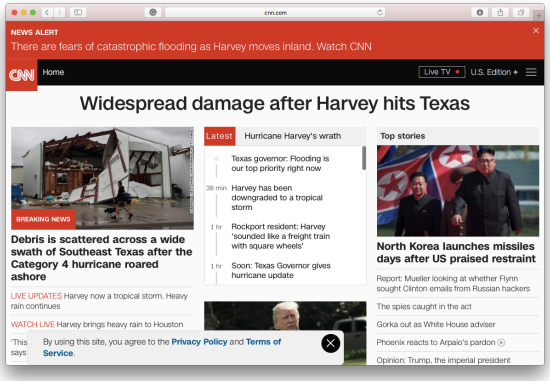


http://www.cnn.com

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000
- HTTP request method: GET
- URI: http://www.cnn.com
- Protocol: HTTP/1.1
- HTTP status code: 200
- Bytes sent: 96433

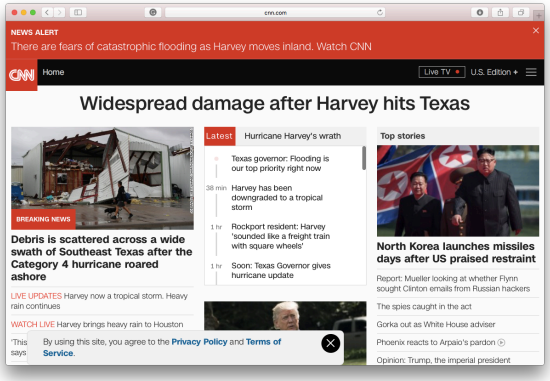


http://www.cnn.com

Server log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 "https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000
- HTTP request method: GET
- URI: http://www.cnn.com
- Protocol: HTTP/1.1
- HTTP status code: 200
- Bytes sent: 96433
- Referring URI: https://www.google.com

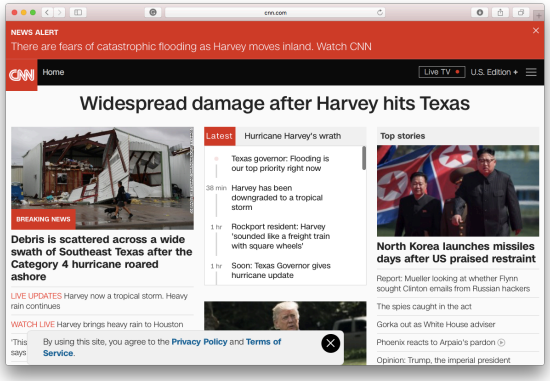


http://www.cnn.com

Server log files

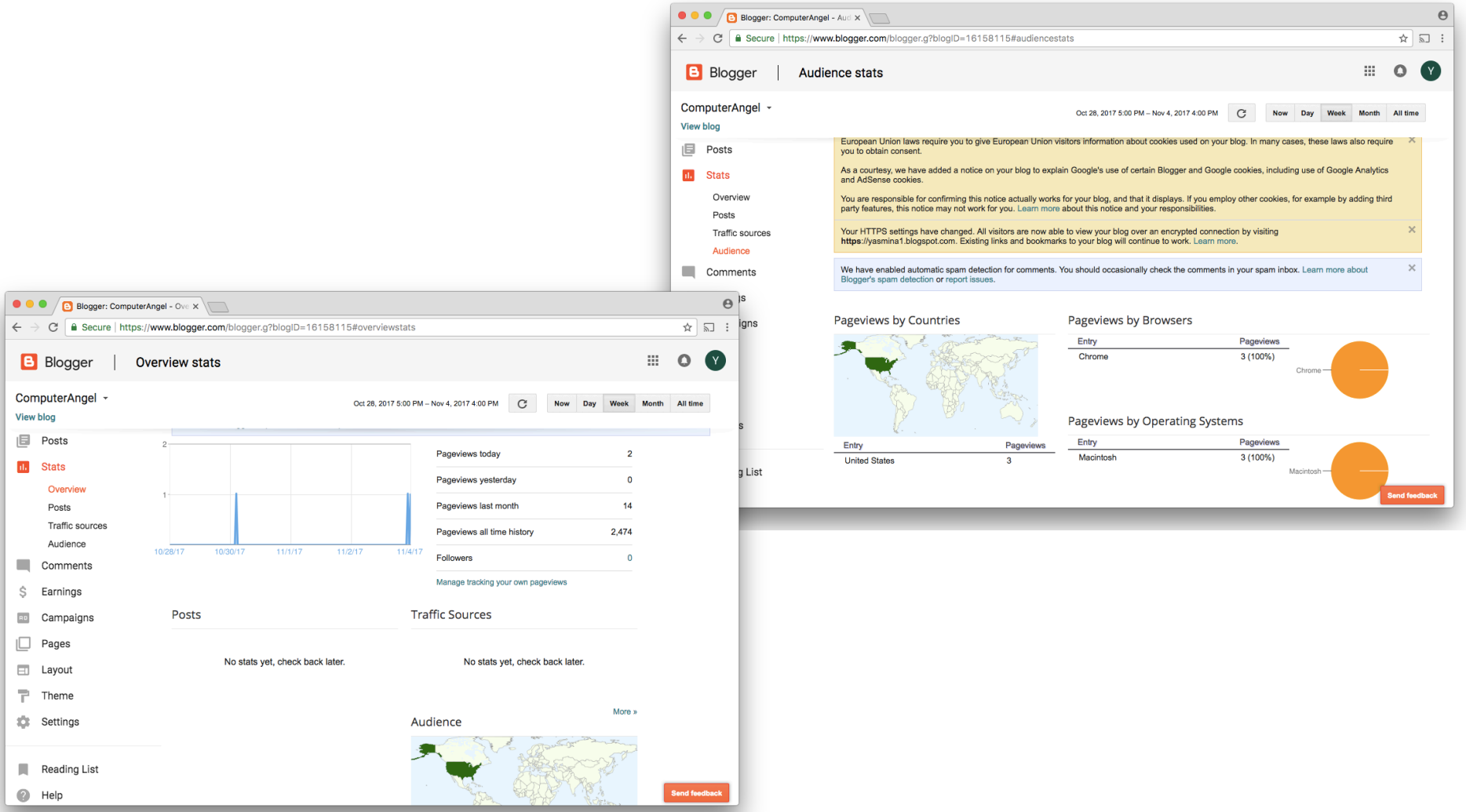
```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 "https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"
```

- Client IP: 0.247.222.86
- Access time: 0/Sep/2017:07+0000
- HTTP request method: GET
- URI: http://www.cnn.com
- Protocol: HTTP/1.1
- HTTP status code: 200
- Bytes sent: 96433
- Referring URI: https://www.google.com
- User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7

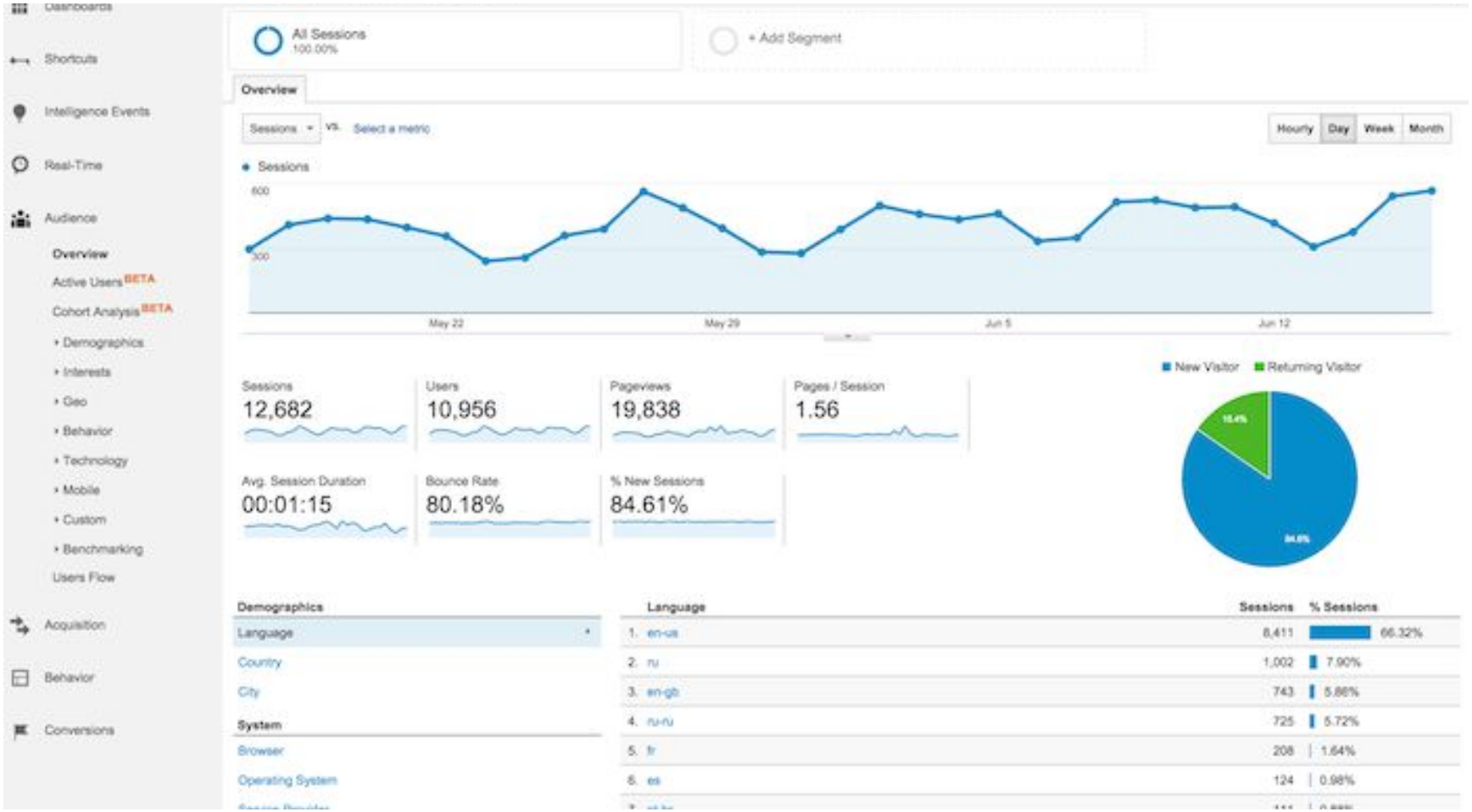


http://www.cnn.com

What we get from the log
Web usage data processing



Google analytics



Source: https://moz.com/blog/absolute-beginners-guide-to-google-analytics

Analyzing Web usage data

- Data preprocessing
- Data cleaning
- User identification
- Session identification
- Pattern detection

Data preprocessing

- Parse log files

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/
1.1" 200 96433 ”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac
OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77
Safari/535.7"
```

Client IP	Access time	HTTP request method	URI	Protocol	HTTP status code	Bytes sent	Referring URI	User-Agent
0.247.222.86	0/Sep/ 2017:07+0000	GET	http://www.cnn.com	HTTP/1.1	200	96433	https://www.google.com	Mozilla/5.0 (Macintosh; …

Python library for parsing logs: https://github.com/rory/apache-log-parser

Data cleaning

Filter our irrelevant requests

0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET https://www.google.com HTTP/1.1" 200 96433 " " "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"

0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433 "https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"

0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET http://money.cnn.com/2017/10/31/technology/gadgets/iphone-x-first-impressions/index.html HTTP/1.1" 200 96433 " http://www.cnn.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7"

But I viewed only two cnn pages = 2 requests

~400 requests

Data cleaning

```
0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308/
http://www.jcdl.org/  HTTP/1.1" 200 2137 "-"
"Mozilla/5.0"

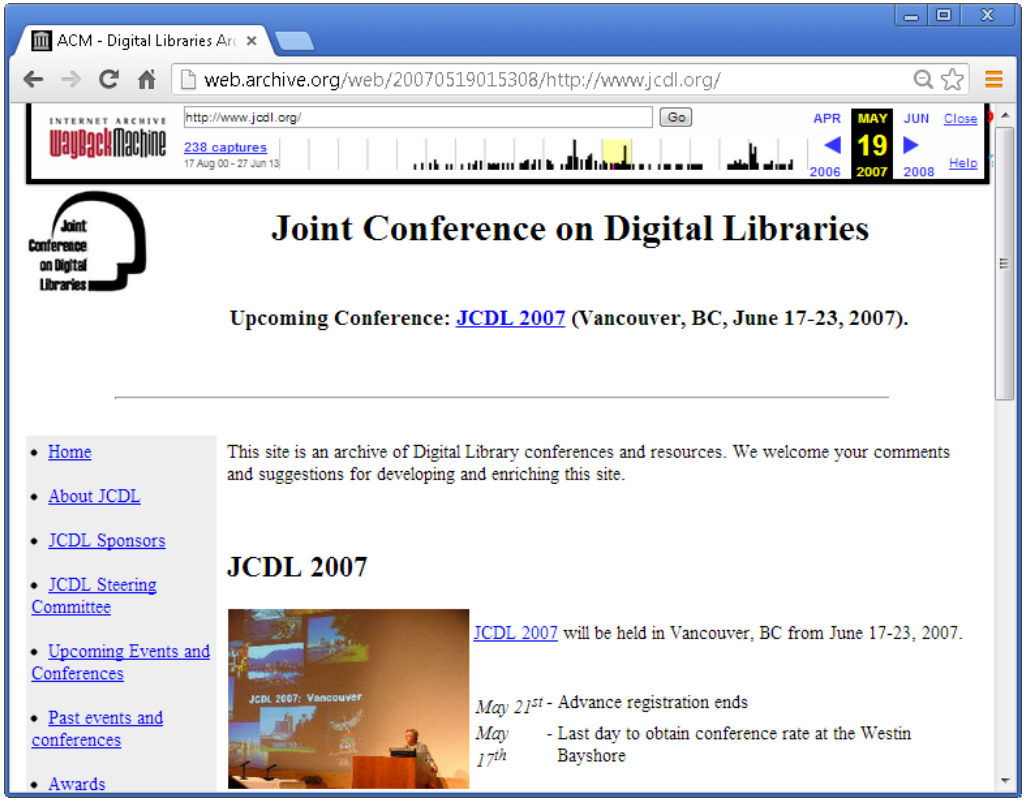
0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308im_/
http://www.jcdl.org/images/jcdl2007-edie.jpg
HTTP/1.1" 200 2137 "-" "Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://staticweb.archive.org/images/toolbar/
wayback-toolbar-logo.png HTTP/1.1" 200 3700
"-" "Mozilla/5.0"

0.151.147.108 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20100102003557/
about:blank HTTP/1.1" 302 0 "www.xx.com"
"Mozilla/4.0"

0.26.129.146 - - [02/Feb/2012:00:01:54] "GET
http://web.archive.org/web/20140004100000/
http://www.jcdl.org/ HTTP/1.1" 302 0 "-"
"Mozilla/5.0"
```

http://web.archive.org/web/20070519015308/
http://www.jcdl.org/



Embedded resources

```
0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308/
http://www.jcdl.org/  HTTP/1.1" 200 2137 "-"
"Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308im_/
http://www.jcdl.org/images/jcdl2007-edie.jpg
HTTP/1.1" 200 2137 "-" "Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://staticweb.archive.org/images/toolbar/
wayback-toolbar-logo.png HTTP/1.1" 200 3700
"-" "Mozilla/5.0"

0.151.147.108 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20100102003557/
about:blank HTTP/1.1" 302 0 "www.xx.com"
"Mozilla/4.0"

0.26.129.146 - - [02/Feb/2012:00:01:54] "GET
http://web.archive.org/web/20140004100000/
http://www.jcdl.org/ HTTP/1.1" 302 0 "-"
"Mozilla/5.0"
```

http://web.archive.org/web/20070519015308/
http://www.jcdl.org/

Embedded resources

```
0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308/
http://www.jcdl.org/  HTTP/1.1" 200 2137 "-"
"Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308im_/
http://www.jcdl.org/jcdl2007-edie.jpg
HTTP/1.1" 200 2137 "-" "Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://staticweb.archive.org/images/toolbar/
wayback-toolbar-logo.png HTTP/1.1" 200 3700
"-" "Mozilla/5.0"

0.151.147.108 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20100102003557/
about:blank HTTP/1.1" 302 0 "www.xx.com"
"Mozilla/4.0"

0.26.129.146 - - [02/Feb/2012:00:01:54] "GET
http://web.archive.org/web/20140004100000/
http://www.jcdl.org/ HTTP/1.1" 302 0 "-"
"Mozilla/5.0"
```

http://web.archive.org/web/20070519015308/
http://www.jcdl.org/

Static resources

```
0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308/
http://www.jcdl.org/  HTTP/1.1" 200 2137 "-"
"Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308im_/
http://www.jcdl.org/jcdl2007-edie.jpg
HTTP/1.1" 200 2137 "-" "Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://staticweb.archive.org/images/toolbar/
wayback-toolbar-logo.png HTTP/1.1" 200 3700
"-" "Mozilla/5.0"

0.151.147.108 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20100102003557/
about:blank HTTP/1.1" 302 0 "www.xx.com"
"Mozilla/4.0"

0.26.129.146 - - [02/Feb/2012:00:01:54] "GET
http://web.archive.org/web/20140004100000/
http://www.jcdl.org/ HTTP/1.1" 302 0 "-"
"Mozilla/5.0"
```

http://web.archive.org/web/20070519015308/
http://www.jcdl.org/

Static resources

```
0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308/
http://www.jcdl.org/  HTTP/1.1" 200 2137 "-"
"Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20070519015308im_/
http://www.jcdl.org/jcdl2007-edie.jpg
HTTP/1.1" 200 2137 "-" "Mozilla/5.0"

0.11.160.135 [02/Feb/2012:00:01:03] "GET
http://staticweb.archive.org/images/toolbar/
wayback-toolbar-logo.png HTTP/1.1" 200 3700
"-" "Mozilla/5.0"

0.151.147.108 [02/Feb/2012:00:01:03] "GET
http://web.archive.org/web/20100102003557/
about:blank HTTP/1.1" 302 0 "www.xx.com"
"Mozilla/4.0"

0.26.129.146 - - [02/Feb/2012:00:01:54] "GET
http://web.archive.org/web/20140004100000/
http://www.jcdl.org/ HTTP/1.1" 302 0 "-"
"Mozilla/5.0"
```

http://web.archive.org/web/20070519015308/
http://www.jcdl.org/

User identification

- Grouping: based on the IP and User-Agent

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET https://www.google.com HTTP/1.1" 200 96433 ” "
"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/
16.0.912.77 Safari/535.7”

0.247.222.86 - - [0/Sep/2017:07:05:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433
”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7
(KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7”

0.247.222.86 - - [0/Sep/2017:07:12:46 +0000] "GET http://money.cnn.com/2017/10/31/technology/
gadgets/iphone-x-first-impressions/index.html HTTP/1.1" 200 96433 ” http://www.cnn.com"
"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/
16.0.912.77 Safari/535.7”
```

Same IP

Session identification

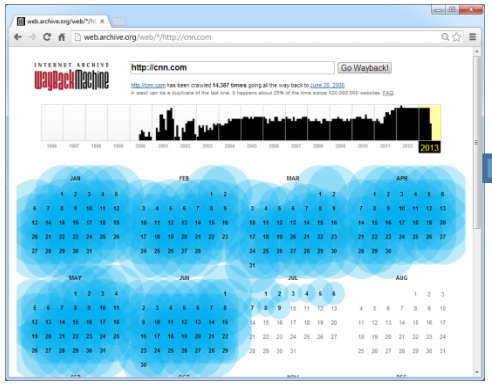
- Segment the user activity record of each user into sessions, each representing a single visit to the site
- Threshold timeout: 10 minutes Liu et al. 2007, Spiliopoulou et al. 2003

```
0.247.222.86 - - [0/Sep/2017:07:03:46 +0000] "GET https://www.google.com HTTP/1.1" 200 96433 ” "
"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/
16.0.912.77 Safari/535.7”

0.247.222.86 - - [0/Sep/2017:07:05:46 +0000] "GET http://www.cnn.com HTTP/1.1" 200 96433
”https://www.google.com" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7
(KHTML, like Gecko) Chrome/16.0.912.77 Safari/535.7”

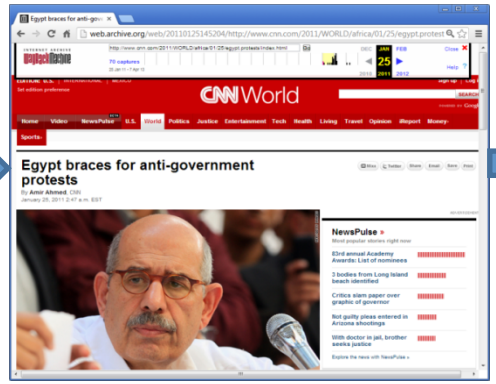
0.247.222.86 - - [0/Sep/2017:07:12:46 +0000] "GET http://money.cnn.com/2017/10/31/technology/
gadgets/iphone-x-first-impressions/index.html HTTP/1.1" 200 96433 ” http://www.cnn.com"
"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8) AppleWebKit/535.7 (KHTML, like Gecko) Chrome/
16.0.912.77 Safari/535.7”
```

Session: set of Web pages requested by a particular user in a single visit



p1

1 mins



p2

4 mins

p3

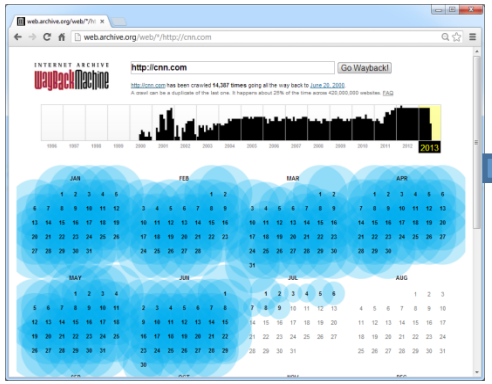
3 mins

p4

9 mins

p5

Session: set of Web pages requested by a particular user in a single visit



p1

1 mins

4 mins

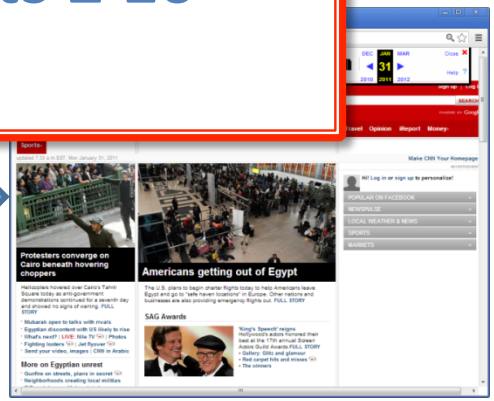
p3

Time between two requests ≤ 10

3 mins

p4

9 mins



p5

User 1

User 2

Session 1

Session 2

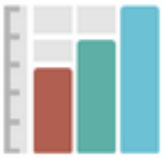
Session 3

Session 4

Session 1

Session 2

Session 2



page views

users

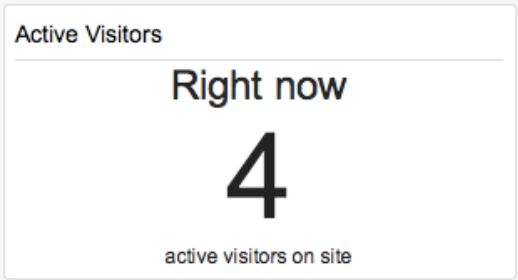
visits

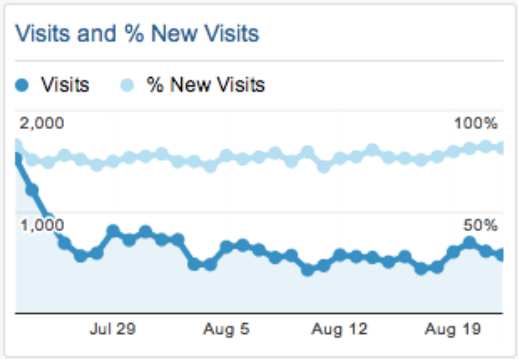
time spent on the site

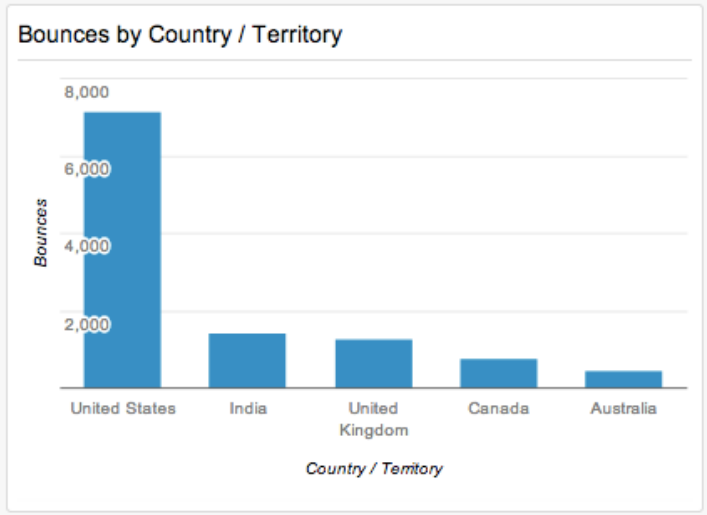
where people come from

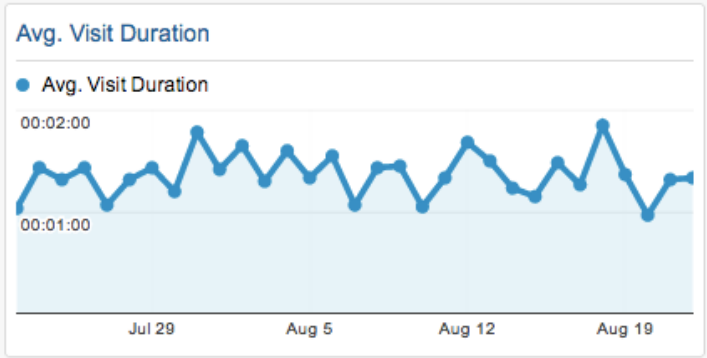
Log file → Users → sessions → patterns

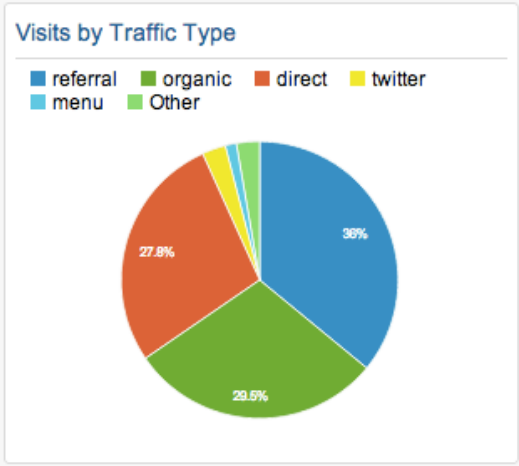
Google analytics

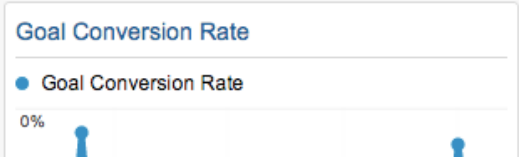




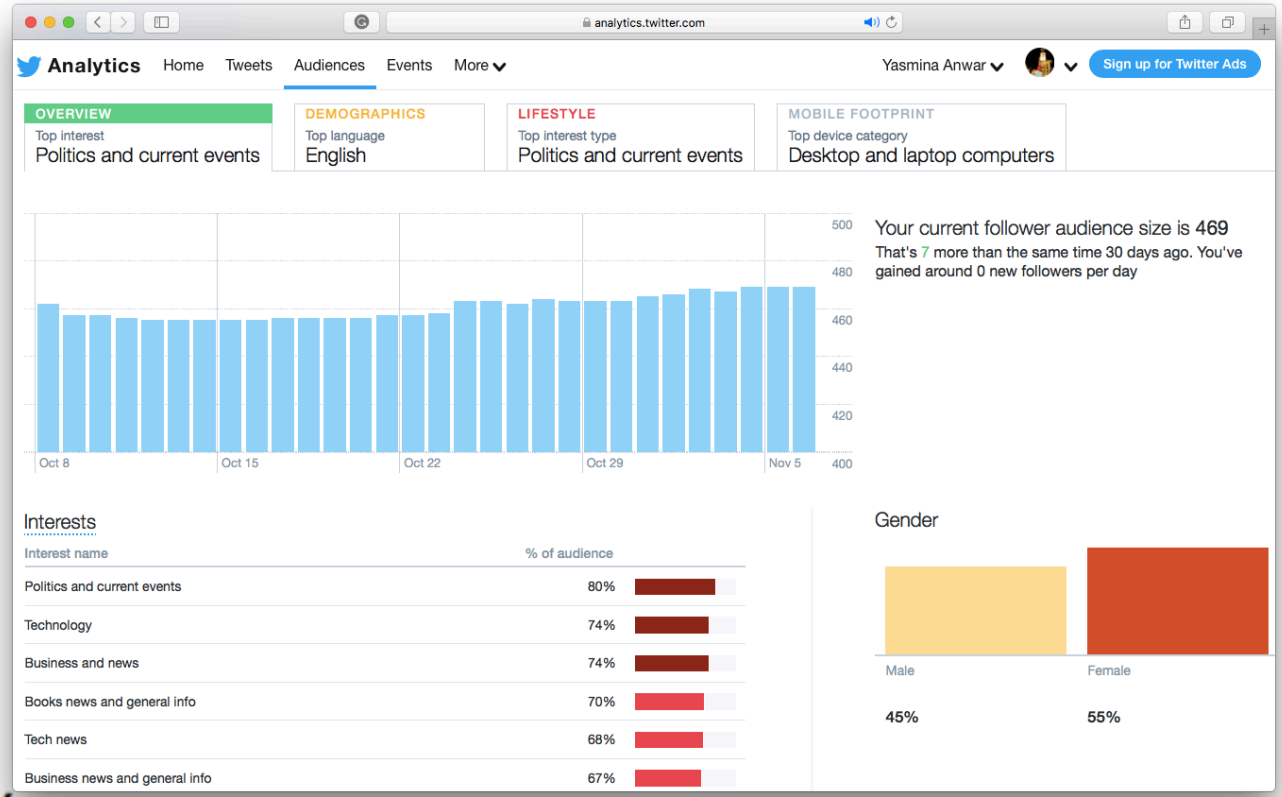


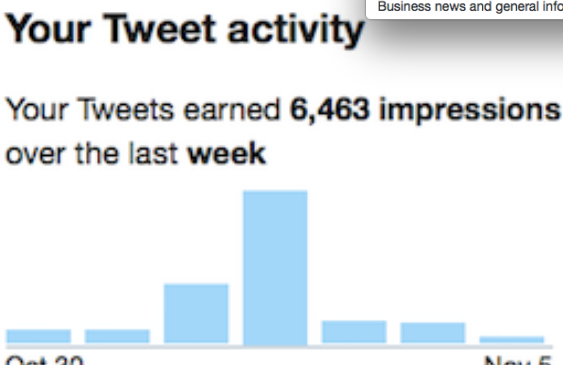






Twitter activity





Resources

- Chapter 12: Web Usage Mining by B. Mobasher (pdf)
- Access Patterns for Robots and Humans in Web Archives (pdf)

Next

- How to generate good visualizations