FINISHED

# Extracting web links from WAT

**What this notebook does:**

Develops map-reduce functions to extract from WAT files the weighted directed graph of domain-to-domain links, where the weight is the number of page URIs linked to. Edge lists are written to S3. At the end we plot some degree distributions.

---

See https://github.com/commoncrawl/cc-pyspark (https: //github.com/commoncrawl/cc-pyspark) for pre-canned solution. Here let's derive an RDD from the observations above.

For each json record, we seen that the current URL is contained in the value
`['Envelope']['WARC-Header-Metadata']['WARC-Target-URI']`

See https://iipc.github.io/warc-specifications/specifications/warc-format/warc-1.1/ (https: //iipc.github.io/warc-specifications/specifications/warc-format/warc-1.1/). In particular:

> **WARC-Target-URI**
> The original URI whose capture gave rise to the information content in this record. In the context of web harvesting, this is the URI that was the target of a crawler’s retrieval request. For a ‘revisit’ record, it is the URI that was the target of a retrieval request. Indirectly, such as for a ‘metadata’, or ‘conversion’ record, it is a copy of the WARC-Target-URI appearing in the original record to which the newer record pertains. The URI in this value shall be properly escaped according to [RFC3986] and written with no internal whitespace.

Some outgoing links are contained in
`['Envelope']['Payload-Metadata']['HTTP-Response-Metadata']['HTML-Metadata']['Head']['Link']`
which is itself a list of dicts with keys
`'path', 'rel', 'url'`
As the documentation below shows, these are not links of interest – these are contained in
`['Envelope']['Payload-Metadata']['HTTP-Response-Metadata']['HTML-Metadata']['Links']`
whose dicts have keys
`'path','target','text','url'`

See
https://webarchive.jira.com/wiki/spaces/Iresearch/pages/13467719/Web+Archive+Metadata+File+Specifi
(https:
//webarchive.jira.com/wiki/spaces/Iresearch/pages/13467719/Web+Archive+Metadata+File+Specificatior
In particular:

> **HTML-Metadata**

```
"HTML-Metadata": {
  "Head": {
   "Metas": [
    {
     "content": "Jim DeMint - U.S. Senate South Carolina",
     "name": "description"
    },
    {
     "content": "demint, jim deMint, senate, south carolina, republi
     "name": "keywords"
    }
   ],
   "Title": "Jim DeMint - U.S. Senate"
  },
  "Links": [
   {
    "path": "TABLE@/background",
    "url": "/demint_images/top_bg1.gif"
   },
   {
    "path": "A@/href",
    "text": "clicking here.",
    "url": "http://jimdemint.com/demint_contents/issues/jobs/"
   }]
}
```

**Links**
Indicates the absolute URI of an outgoing link from the capture, the URI of the link as it appears on the page, the type of outgoing link (link, embed, redirect or other), XPath-suffix of link (best-effort), the alt attribute and anchor-text (truncated to 100 bytes)
**Head**
Attributes and values of HTML head elements: title, base, style, link, meta and script

Took 0 sec. Last updated by anonymous at October 14 2017, 10:49:22 AM.

```
%pyspark

import boto
from boto.s3.key import Key
from gzipstream import GzipStreamFile
from pyspark.sql.types import *
import warc

import ujson as json

watlist = sc.textFile("s3://commoncrawl/crawl-data/CC-MAIN-2017-04/wat.paths.gz")
watlist.cache()
```

READY

```
s3://commoncrawl/crawl-data/CC-MAIN-2017-04/wat.paths.gz MapPartitionsRDD[1] at textFile at
 NativeMethodAccessorImpl.java:0
```

```
%pyspark
```

READY

```
from __future__ import print_function

nfiles = 2048
files = sc.parallelize(watlist.take(nfiles))

def unpack(uri):
    conn = boto.connect_s3(anon=True, host='s3.amazonaws.com')
    bucket = conn.get_bucket('commoncrawl')
    key_ = Key(bucket, uri)
    file_ = warc.WARCFile(fileobj=GzipStreamFile(key_))
    return file_

def extract_json(id_, iterator):
    for uri in iterator:
        file = unpack(uri)
        for record in file:
            if record['Content-Type'] == 'application/json':
                try:
                    content = json.loads(record.payload.read())
                    yield content['Envelope']
                except:
                    yield None

json_rdd = files.mapPartitionsWithIndex(extract_json)
json_rdd.cache()

print("Nr json records:", json_rdd.count())
```

See below for timings.

READY

```
%pyspark
```

READY

```
import urlparse
from collections import Counter

def parse_links(record):

    try:
        page_url = record['WARC-Header-Metadata']['WARC-Target-URI']
        page_domain = urlparse.urlparse(page_url).netloc
        links = record['Payload-Metadata']['HTTP-Response-Metadata']['HTML-Metadata']['Lin
        out_links = Counter([urlparse.urlparse(url['url']).netloc for url in links])
        return (page_domain, out_links)
    except:
        return None

links_rdd = json_rdd\
            .map(parse_links)\
            .filter(lambda x: x is not None)\
            .reduceByKey(lambda x,y: x+y)\
            .map(lambda x: {'domain': x[0], 'out': dict(x[1])})
links_rdd.cache()
json_rdd.unpersist()
```

```
PythonRDD[4] at RDD at PythonRDD.scala:48
```

```
%pyspark
```

READY

```
from __future__ import print_function
```

```
page_link_count = links_rdd\
                    .map(lambda x: (1, sum(x['out'].values())))\
                    .reduceByKey(lambda x,y: x+y)\
                    .collect()[0][1]

print("Nr page links:", page_link_count)
print("Nr domain links:", links_rdd.count())
```

```
Nr page links: 8102680487
Nr domain links: 814114
```

Timings: READY

| Cluster | nr files | json record count | page/domain link count |
|---|---|---|---|
| 16 x m3.2xlarge | 128 | 21.0M in 11 min 39 sec | 1.0B --> 199k in 18 min 18 sec |
| 16 x m3.2xlarge | 256 | 41.9M in 22 min 42 sec | 2.0B --> 283k in 39 min 38 sec |
| 16 x m4.2xlarge | 512 | 83.8M in 13 min 9 sec | 4.0B --> 432k in 27 min 7 sec |
| 16 x m4.2xlarge | 1024 | 167M in 27 min 40 sec | 8.1B --> 814k in 56 min 14 sec |

Let's eyeball what's in `links_rdd`. Note that most domains also contain the empty string in their links. This is output by `urlparse.urlparse`, and suggests that the linked URL was in the same domain, e.g. a local file path.

See https://docs.python.org/2/library/urlparse.html (https: //docs.python.org/2/library/urlparse.html).

READY

```
%pyspark

outputURI = "s3://billsdata.net/CommonCrawl/webgraph_%d_WAT_files" % nfiles

codec = "org.apache.hadoop.io.compress.GzipCodec"
links_rdd.saveAsTextFile(outputURI, codec)
```

Read from the S3 stored files: READY

READY

```
%pyspark

from __future__ import print_function

inputURI = "s3://billsdata.net/CommonCrawl/webgraph_1024_files/"

#links_rdd = sc.textFile(inputURI).map(eval)
#links_rdd.cache()

domain_link_count = links_rdd\
                    .map(lambda x: [len(x['out']), sum(x['out'].values())])\
                    .aggregate((0, 0, 0),
                               lambda acc, value: (acc[0] + 1, acc[1] + value[0], acc[2]
                               lambda acc1, acc2: (acc1[0] + acc2[0], acc1[1] + acc2[1],

print("Nr domains: %18d" % domain_link_count[0])
print("Nr domain links: %13d" % domain_link_count[1])
print("Nr page links: %15d" % domain_link_count[2])
```

```
Nr domains:              814114
Nr domain links:       24412865
Nr page links:       8102680487
```

```
%pyspark

from pprint import pprint

sample = links_rdd.take(10)
for x in sample:
    #x['out'].pop('', None)
    pprint(x)
```

READY

```
{'domain': u'vkaraoke.org',
 'out': {'': 11651,
         u'mc.yandex.ru': 100,
         u'ok.ru': 100,
         u'vk.com': 100,
         u'vkaraoke.org': 3051,
         u'www.facebook.com': 100}}
{'domain': u'kidsactivitycenter.com', 'out': {u'mcc.godaddy.com': 1}}
{'domain': u'kkbelter.hu',
 'out': {'': 9,
         u'belsoepiteszet.kkbelter.hu': 2,
         u'foto.kkbelter.hu': 2,
         u'www.kkbelter.hu': 1}}
{'domain': u'parismp.com', 'out': {'': 11, u'www.pcdepot.co.jp': 1}}
{'domain': u'adonizm.com',
 'out': {'': 233,
         u'adonizm.com': 11443,
         u'adonizmdotcom.tumblr.com': 81
```

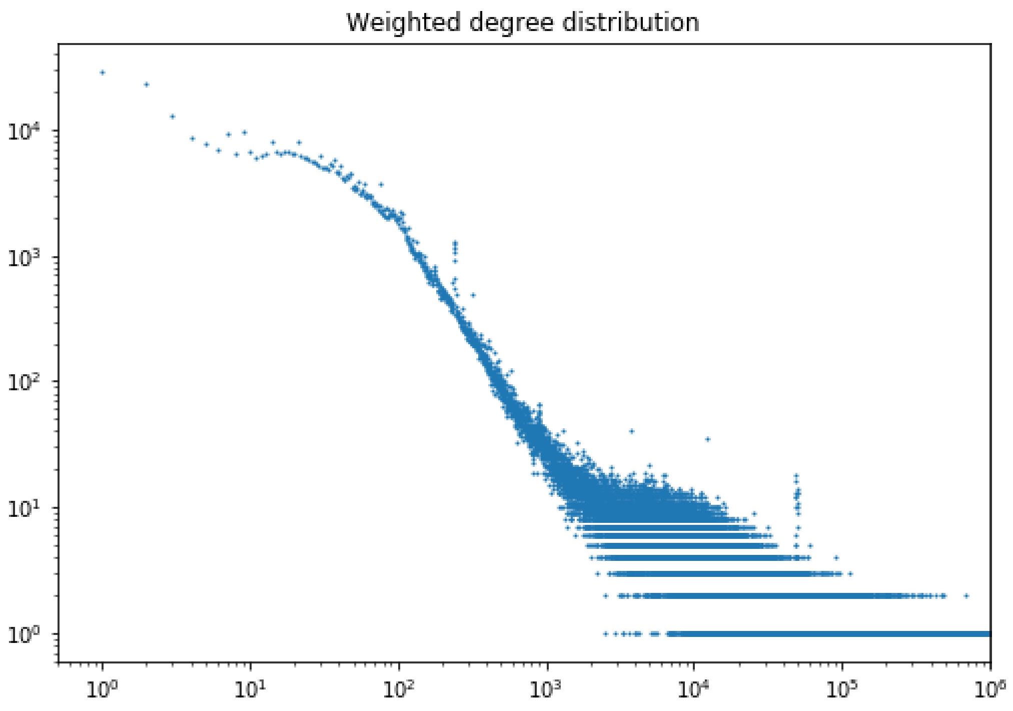
Let's view the out-degree distribution:

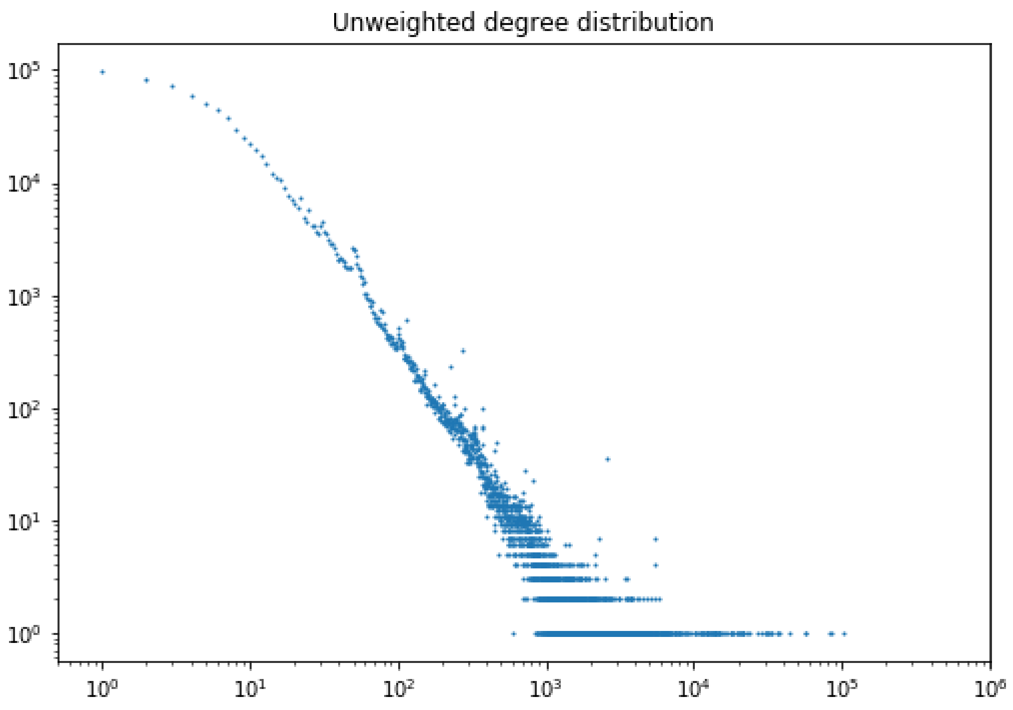
READY

```
%pyspark

from collections import Counter
import matplotlib.pyplot as plt

def degree(record):
    record.pop('', None)
    return [len(record['out'].keys()), sum(record['out'].values())]

out_degree = links_rdd.map(degree)
wtd_degree = out_degree.map(lambda x: x[1]).collect()
unwtd_degree = out_degree.map(lambda x: x[0]).collect()

wtd_distribution = Counter(wtd_degree)
unwtd_distribution = Counter(unwtd_degree)

plt.scatter(wtd_distribution.keys(), wtd_distribution.values(), s=1.0)
plt.xlim([0.5,1e06])
plt.xscale("log")
plt.yscale("log")
plt.title("Weighted degree distribution")
plt.show()
```

READY

```
plt.scatter(unwtd_distribution.keys(), unwtd_distribution.values(), s=1.0)
plt.xlim([0.5,1e06])
plt.xscale("log")
plt.yscale("log")
plt.title("Unweighted degree distribution")
plt.show()

"""
plt.scatter(unwtd_degree, wtd_degree, s=0.2)
plt.xscale("log")
plt.yscale("log")
plt.title("Weighted against unweighted degrees")
plt.show()
"""
```





```
'\nplt.scatter(unwtd_degree, wtd_degree, s=0.2)\nplt.xscale("log")\nplt.yscale("log")\nplt.title("Weighted against unweighted degrees")\nplt.show()\n'
```

```
%pyspark

links_rdd.unpersist()
```

READY

```
PythonRDD[53] at RDD at PythonRDD.scala:48
```

```
%pyspark
```

READY