

Lab 9 – PageRank over Wikipedia

CC5212-1

May 4, 2016

Today we're going to find out what are the most important articles in Wikipedia using PageRank (the algorithm proposed by Google to decide the most important pages on the Web).

As input, you are given a TSV (tab-separated values) file with two columns. This file encodes a directed graph of links between articles in Wikipedia. In more detail, for any two Wikipedia Articles **A** and **B**, there exists a link $A \rightarrow B$ in the graph if Article **A** contains a link to Article **B**. For example, the following lines in the input mean that the article on the left links to the three articles on the right:

```
http://es.wikipedia.org/wiki/Andorra http://es.wikipedia.org/wiki/España
http://es.wikipedia.org/wiki/Andorra http://es.wikipedia.org/wiki/Portugal
http://es.wikipedia.org/wiki/Andorra http://es.wikipedia.org/wiki/Francia
```

The main task of the lab is to code a PageRank algorithm that will compute rankings of the importance of articles in the graph based on how they are linked. Later we will use these ranks to improve the search features developed last week.

- Download the code project from <http://aidanhogan.com/teaching/cc5212-1-2016/lab/09/mdp-lab09.zip> and open it in Eclipse. We'll be using `OIDEncode`, `PageRankGraph`, `SortByRank` and `OIDDecode`. The only class we'll need to code in is `PageRankGraph`; the others are done!
- Start downloading the data from <http://aidanhogan.com/teaching/data/wiki/es/es-wiki-links.tsv.gz>, which contains 31,506,565 lines, with a link encoded in each line (*there is no need to unzip this file; it's 4GB uncompressed; we can read a GZIP input stream from the Java program later*). If you open up the second file, <http://aidanhogan.com/teaching/data/wiki/es/es-wiki-links-10k.tsv>, it contains the first 10,000 lines so you can see the format. Each line has a link like above.
- Open up the code project. Since the data are large, first we're going to do a little trick that will help us manage the data in memory: we are going to map the full URL strings in the links file to unique integer IDs. The code is already done for you in `OIDEncode`.¹ Call `OIDEncode` with

```
-i IN-DIR/es-wiki-links.tsv.gz -igz -o OUT-DIR/es-wiki-links.oid.gz -ogz
-d OUT-DIR/es-wiki-links.dict.gz -dgz
```

The `-o` parameter gives the location of the output file that will contain the encoded graph with OID (Object ID) integers. The `-d` parameter records the mapping from strings to OIDs (what we call the dictionary) that we will use to decode the file later.

- Our graph is ready to be ranked. Now to the main task: code the PageRank algorithm. Open up the `PageRankGraph` Java class. There's some code already done for you to load the compressed graph into memory as an `int[][] graph`. To get the outlinks of node i , for example, we can access `int[] out_i = graph[i]`, (it will be important to remember that `out_i` may be null if i has no outlinks).

¹It doesn't do anything fancy except load the strings in memory and assign them an ID. To avoid loading the strings in memory, we could also sort the strings using the hard-drive and assign sequential IDs, then sort the graph, join on ... it's doable but more complicated. ☺

- Your task is to code the `rankGraph(int [] [] graph)` method.
 - First get the number of nodes in the graph.
 - Create two arrays (`double[]`) to hold the rank of each node. The first array holds the current rank (`newranks`). The second array holds the rank from the previous round (`oldranks`).
 - We need to initialise some ranks. Into `oldranks` we need to set an initial value for every node. What might it be? *Remember that all ranks in both vectors should always add up (modulo minor rounding issues) to 1.*
 - There is a number of iterations defined at the top of the class file as `ITERS`. We need to start the iteration loop (`for(int i=0; i<ITERS, i++){ ... }`).
 - From the last lecture, hopefully you remember that there are two types of ranks a node gets: a “link rank” and a “(random) jump rank”. Every node gets the same jump rank (every node links to all nodes evenly with $1 - d$ times its score; nodes with no outlinks are assumed to link to every node equally). We are first going to compute this jump rank:²
 - * Within the iteration loop, iterate through the graph once and generate two sums: one for the ranks of all nodes with at least one outlink (r_0) and one for all nodes with no outlinks (r_1). Sums are computed from `oldranks`.
 - * Compute the total jump rank to be shared across all nodes as $r_0 \times (1 - d) + r_1$. The value for d is 0.85 (given as the static variable `D` in the Java class).
 - * Compute the share of jump rank for each node.
 - * Initialise `newranks` with the universal rank for every node.
 - Next we compute the “link rank”, which is the rank that nodes give each other through links. Every node splits a ratio of d (i.e., 85% when $d = 0.85$) of its rank from the previous round (`oldranks`) equally with the nodes its links to.
 - * Iterate through the graph. For each node with outlinks
 - Compute the share of rank it gives to its outlinks.
 - Iterate over the outlinks and add that share to each of their `newranks`.
 - Last but not least, we want to track some statistics from the computation. At the end of each iteration compute a sum of all ranks (`newranks`) and an epsilon (the sum of the absolute differences between `oldranks` and `newranks` for each node). Print both to console! Hopefully you see the sum stay close to one and the epsilon drop quite low.
 - One last thing ... any guesses what it is? ☺
- Run the code for the full file (`-i` for input file, `-igz` if input is GZipped, `-o` for output file, `-ogz` to GZip output).
- Next run `SortByRank` for the output above (same style of arguments as before).
- Next call `OIDDecode`. You need to pass as input the sorted rank file, the dictionary, as well as the column you want to decompress (`-n 0`).
- Submit your code to u-cursos by Monday night. If you have trouble, come to the lecture on Monday. We will do PageRank exercises and I can help you with the code. **Note, we will be using this code for the next lab, so I will need to set a final deadline before the next lab.**

²There's a couple of ways to do this **other than what's shown**. For example, knowing the sum is 1, we could just compute $\frac{1 \times 0.15 + 0.85 \times x}{n}$ where x is the sum of the ranks of all nodes with no outlinks.)