APRIORI ALGORITHM

CS 634

DATA MINING

Advance Implementation Project

Project By:
Charanpreet Kaur Dhir
(ckd22@njit.edu)

Under Professor:
Jason Wang
(wangj@njit.edu)

HITS ALGORITHM

Hyperlink-Induced Topic Search (HITS; also known as hubs and authorities) is a link analysis algorithm that rates Web pages, developed by Jon Kleinberg.

The idea behind Hubs and Authorities stemmed from a particular insight into the creation of web pages when the Internet was originally forming; that is, certain web pages, known as hubs, served as large directories that were not actually authoritative in the information that they held, but were used as compilations of a broad catalog of information that led users direct to other authoritative pages.[1]

Goal of The Project:

Using search engine to search for 30 web pages related to "Deep Learning.'' Creating a root set that contains the 30 web pages, called seed pages. The root set is then expanded to a base set or neighborhood graph, by adding all of the pages that the root-set pages link to, and all of the pages that link to a page in the root set, up to a size cutoff threshold k where k is a user-specified parameter value. Each page in the neighborhood graph is initially assigned an authority weight of 1 and a hub weight of 1. Then we used the HITS algorithm to iteratively update the authority weight and hub weight and then normalize the algorithm so that the weights converge.

Algorithm :

We consider two types of updates: Authority Update Rule and Hub Update Rule. In order to calculate the hub/authority scores of each node, repeated iterations of the Authority Update Rule and the Hub Update Rule are applied. A k-step application of the Hub-Authority algorithm entails applying for k times first the Authority Update Rule and then the Hub Update Rule.

Authority update rule

$\forall p$, we update $\mathrm{auth}(p)$ to be the summation:

$$\mathrm{auth}(p) = \sum_{i=1}^{n} \mathrm{hub}(i)$$

where n is the total number of pages connected to p and i is a page connected to p. That is, the Authority score of a page is the sum of all the Hub scores of pages that point to it.

Hub update rule

$\forall p$, we update $\mathrm{hub}(p)$ to be the summation:

$$\mathrm{hub}(p) = \sum_{i=1}^{n} \mathrm{auth}(i)$$

where n is the total number of pages p connects to and i is a page which p connects to. Thus a page's Hub score is the sum of the Authority scores of all its linking pages

Normalization

The final hub-authority scores of nodes are determined after infinite repetitions of the algorithm. As directly and iteratively applying the Hub Update Rule and Authority Update Rule leads to diverging values, it is necessary to normalize the matrix after every iteration. Thus the values obtained from this process will eventually converge.

Pseudocode

The hub and authority values converge in the pseudocode below.

```
1 G := set of pages
2 for each page p in G do
3   p.auth = 1 // p.auth is the authority score of the page p
4   p.hub = 1 // p.hub is the hub score of the page p
5 function HubsAndAuthorities(G)
6   for step from 1 to k do // run the algorithm for k steps
7     norm = 0
8     for each page p in G do  // update all authority values first
9       p.auth = 0
10      for each page q in p.incomingNeighbors do // p.incomingNeighbors is the set of pages that link to p
11         p.auth += q.hub
12      norm += square(p.auth) // calculate the sum of the squared auth values to normalise
13    norm = sqrt(norm)
14    for each page p in G do  // update the auth scores
15      p.auth = p.auth / norm  // normalise the auth values
16    norm = 0
17    for each page p in G do  // then update all hub values
18      p.hub = 0
19      for each page r in p.outgoingNeighbors do // p.outgoingNeighbors is the set of pages that p links to
20        p.hub += r.auth
21      norm += square(p.hub) // calculate the sum of the squared hub values to normalise
22    norm = sqrt(norm)
23    for each page p in G do  // then update all hub values
24      p.hub = p.hub / norm   // normalise the hub values
```

Root and Neighborhood set related to Deep Learning

```
afsaccess1-56 datamining >: python abc.py
Printing Root_Set for Deep Learning
https://www.deeplearning.ai/

https://www.coursera.org/specializations/deep-learning

https://www.udemy.com/deeplearning/

https://www.forbes.com/sites/bernardmarr/2018/10/01/what-is-deep-learning-ai-a-simple-guide-with-8-practical-examples/

https://www.coursera.org/learn/neural-networks-deep-learning

https://www.datacamp.com/courses/deep-learning-in-python

http://deeplearning.stanford.edu/tutorial/

https://www.deeplearningbook.org/

https://www.mathworks.com/discovery/deep-learning.html

https://www.edx.org/professional-certificate/ibm-deep-learning

https://www.udacity.com/course/intro-to-tensorflow-for-deep-learning--ud187

https://blogs.scientificamerican.com/observations/a-deep-dive-into-deep-learning/

https://www.youtube.com/watch%3Fv%3DO5xeyoRL95U

https://en.wikipedia.org/wiki/Deep_learning

https://www.ibm.com/cloud/deep-learning

http://deeplearning.net/

https://skymind.ai/wiki/neural-network

https://aws.amazon.com/deep-learning/

https://www.technologyreview.com/s/513696/deep-learning/

https://searchenterpriseai.techtarget.com/definition/deep-learning-deep-neural-network

https://www.sas.com/en_us/insights/analytics/deep-learning.html
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https://www.sas.com/en_us/insights/analytics/deep-learning.html

https://machinelearningmastery.com/what-is-deep-learning/

https://www.techopedia.com/definition/30325/deep-learning

https://www.edx.org/course/deep-learning-explained-5

https://software.intel.com/en-us/ai/courses/deep-learning

https://deeplearning.mit.edu/

https://www.investopedia.com/terms/d/deep-learning.asp

https://www.oreilly.com/library/view/deep-learning/9781491924570/

https://medium.com/tensorflow/mit-introduction-to-deep-learning-4a6f8dde1f0c

https://github.com/lexfridman/mit-deep-learning

Neighbourhood set: [['https://techcrunch.com/2017/08/08/deeplearning-ai-is-andrew-ngs-new-series-of-deep-learning-classes-on-coursera/', 'https://www.youtube.com/channel/UCcIXc5mJsHVYTZR1maL5l9w', 'https://www.deeplearning.ai/', 'https://www.coursera.org/specializations/deep-learning', 'https://github.com/JudasDie/deeplearning.ai', 'https://www.kdnuggets.com/2018/01/journey-into-deep-learning.html', 'https://www.forbes.com/sites/bernardmarr/2018/10/01/what-is-deep-learning-ai-a-simple-guide-with-8-practical-examples/', 'https://en.wikipedia.org/wiki/Andrew_Ng', 'https://www.glassdoor.com/Overview/Working-at-deeplearning-ai-EI_IE2126762.11,26.htm', 'https://www.technologyreview.com/s/608573/andrew-ngs-next-trick-training-a-million-ai-experts/', 'https://towardsdatascience.com/thoughts-after-taking-the-deeplearning-ai-courses-8568f132153', 'https://www.deeplearningbook.org/', 'https://medium.com/%40andrewng/deeplearning-ai-announcing-new-deep-learning-courses-on-coursera-43af0a368116', 'https://hackernoon.com/an-in-depth-review-of-andrew-ngs-deeplearning-ai-speciliazation-99612991eb61', 'https://twitter.com/deeplearningai_', 'https://www.deeplearning.ai/tensorflow-from-basics-to-mastery/', 'https://www.linkedin.com/company/deeplearningai', 'https://github.com/mbadry1/DeepLearning.ai-Summary', 'https://www.coursera.org/deeplearning-ai', 'https://www.kaggle.com/getting-started/37999', 'https://www.analyticsvidhya.com/blog/2018/10/introduction-neural-networks-deep-learning/', 'http://deeplearning.net/', 'https://www.nvidia.com/en-us/deep-learning-ai/education/', 'https://www.reddit.com/r/MachineLearning/comments/6tgvqd/n_thoughts_after_taking_the_deeplearning_ai/', 'https://www.deeplearning.ai/machine-learning-yearning/', 'https://www.crunchbase.com/organization/deeplearning-ai', 'https://notebooks.azure.com/goldengrape/projects/deeplearning-ai', 'https://deeplearning.mit.edu/', 'https://forums.fast.ai/t/new-mooc-deeplearning-ai/4635', 'https://machinelearningmastery.com/deeplearning-ai-convolutional-neural-networks-deep-learning-specialization-review/']]

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afsaccess1-64 datamining >: python abc.py
Printing Root_Set for Deep Learning
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Source code for building the root and neighbourhood graph

```
from bs4 import BeautifulSoup
from urllib.request import Request, urlopen
import ssl
import re
import requests
import math


def build_root_set(search_term):
    url = "https://www.google.com/search?q="+search_term+"&num=35" #Getting 35 results to compensate for duplicates if any
    raw_page = requests.get(url, headers=header).text
    results = re.findall(r'(?<=<h3 class="r"><a href="/url\?q=).*?(?=&amp)', str(raw_page))
    #k = int(input ("Enter number"))
    return list(set(results))[0:30] #Provides 30 unique of the 35 we requested above

def searchGoogle(query):
    #use google library to search for the key word
    search_results = search(query,tld="com", num=30, stop=30);
    RootSet=[]
    for page in search_results:
        RootSet.append(page)
    return RootSet;

def print_desccriptions(neighborhood):
    descriptions = []

    for page in neighborhood:
        req = Request(page, headers=header)
        html = urlopen(req)
        soup = BeautifulSoup(html)

        title = soup.title.text
        metas = soup.find_all("meta")
        desc = [ meta.attrs['content'] for meta in metas if 'name' in meta.attrs and meta.attrs['name'] == 'description' ]

        if len(title) < 1:
            title = re.findall(r'^(?:https?:\/\/)?(?:[^@\/\n]+@)?(?:www\.)?([^:\/\n]+)', page)
            title = title[0]
        if len(desc) < 1:
            desc = soup.p.text
        else:
            desc = desc[0]
```

```
        if len(desc) > 140:
            desc = desc[0:140]+'...'

        descriptions.append([title, page, desc])

    for page in descriptions:
        print("\n")
        print(page[0],page[1],page[2],'\n\n',sep='\n')

    print_desccriptions(neighborhood)

header = {'user-agent': 'Mozilla/5.0 (X11; U; Linux i686) Gecko/20071127 Firefox/2.0.0.11'}
ssl._create_default_https_context = ssl._create_unverified_context
root_set = build_root_set('Deep+Learning') #Note that spaces have to be replaced with '+'
print(" \n  \t printing  \n \t ")
print("Printing Root_Set for Deep Learning")
for item in root_set:
    print(" \n  \t root sets \n \t ")
    print(item,"\n")


neighborhood_set = []
for root in root_set:
    neighborhood_set.append(build_root_set(root))
    print("Neighbourhood set: ", neighborhood_set)

req = Request("https://www.deeplearning.ai/")
html_page = urlopen(req)

soup = BeautifulSoup(html_page, "lxml")

links = []
for link in soup.findAll('a'):
    item = str(link.get('href'))
    if "http" in item:
        links.append(item)

print(" \n  \n  ")
print(links)


G = links
```

```
for link in soup.findAll('a'):
    item = str(link.get('href'))
    if "http" in item:
        links.append(item)

print(" \n  \n  ")
print(links)


G = links
for p in G:
    auth = 1
    hub = 1
def HubsAndAuthorities(G):
        norm = 0
        for p in G:
           auth = 0
           print("Hi val : ",p)
           for q in root_set:
                auth += hub
                print("q is :", q)
                print("auth:",auth)
           norm += math.sqrt(auth)
           print("norm :", norm)
        norm =math.sqrt(norm)
        for p in G:
            auth = int(auth) / float(norm)
        norm = 0
        for p in G :
            hub = 0
            for r in neighborhood_set :
                hub += auth
            norm += math.sqrt(hub)
        norm = math.sqrt(norm)
        for p in G :
            hub =int(hub) / float(norm)
print ("Hubs: ", hub);
print ("authorities: ", auth)


HubsAndAuthorities(G)

```

HITS Algorithm Implementation on the sample Graph(in java)

```
afsaccess1-82 DS610 >: java hits_8357 -3 -1 Sam_graph.txt

                        HITS for  8357

Base: 0 :
A/H [0] = 0.0909091/0.0909091
A/H [1] = 0.0909091/0.0909091
A/H [2] = 0.0909091/0.0909091
A/H [3] = 0.0909091/0.0909091
A/H [4] = 0.0909091/0.0909091
A/H [5] = 0.0909091/0.0909091
A/H [6] = 0.0909091/0.0909091
A/H [7] = 0.0909091/0.0909091
A/H [8] = 0.0909091/0.0909091
A/H [9] = 0.0909091/0.0909091
A/H [10] = 0.0909091/0.0909091

Iter: 1 :
A/H [0] = 0.0000000/0.3123475
A/H [1] = 0.0000000/0.4685213
A/H [2] = 0.2581989/0.3123475
A/H [3] = 0.2581989/0.3123475
A/H [4] = 0.2581989/0.0000000
A/H [5] = 0.2581989/0.0000000
A/H [6] = 0.2581989/0.0000000
A/H [7] = 0.2581989/0.0000000
A/H [8] = 0.2581989/0.6246950
A/H [9] = 0.5163978/0.3123475
A/H [10] = 0.5163978/0.0000000

Iter: 2 :
A/H [0] = 0.0000000/0.3307907
A/H [1] = 0.0000000/0.4961861
A/H [2] = 0.2797514/0.2205271
A/H [3] = 0.1865010/0.2205271
A/H [4] = 0.1865010/0.0000000
A/H [5] = 0.1865010/0.0000000
A/H [6] = 0.1865010/0.0000000
A/H [7] = 0.2797514/0.0000000
A/H [8] = 0.2797514/0.6615814
A/H [9] = 0.5595029/0.3307907
A/H [10] = 0.5595029/0.0000000
```

```
Iter: 3 :
A/H [0] = 0.0000000/0.3401073
A/H [1] = 0.0000000/0.5101609
A/H [2] = 0.2912332/0.1511588
A/H [3] = 0.1294370/0.1511588
A/H [4] = 0.1294370/0.0000000
A/H [5] = 0.1294370/0.0000000
A/H [6] = 0.1294370/0.0000000
A/H [7] = 0.2912332/0.0000000
A/H [8] = 0.2912332/0.6802146
A/H [9] = 0.5824663/0.3401073
A/H [10] = 0.5824663/0.0000000

Iter: 4 :
A/H [0] = 0.0000000/0.3445086
A/H [1] = 0.0000000/0.5167628
A/H [2] = 0.2968108/0.1020766
A/H [3] = 0.0879440/0.1020766
A/H [4] = 0.0879440/0.0000000
A/H [5] = 0.0879440/0.0000000
A/H [6] = 0.0879440/0.0000000
A/H [7] = 0.2968108/0.0000000
A/H [8] = 0.2968108/0.6890171
A/H [9] = 0.5936217/0.3445086
A/H [10] = 0.5936217/0.0000000

Iter: 5 :
A/H [0] = 0.0000000/0.3465203
A/H [1] = 0.0000000/0.5197804
A/H [2] = 0.2993948/0.0684485
A/H [3] = 0.0591397/0.0684485
A/H [4] = 0.0591397/0.0000000
A/H [5] = 0.0591397/0.0000000
A/H [6] = 0.0591397/0.0000000
A/H [7] = 0.2993948/0.0000000
A/H [8] = 0.2993948/0.6930406
A/H [9] = 0.5987897/0.3465203
A/H [10] = 0.5987897/0.0000000
```

```
Iter: 6 :
A/H [0] = 0.0000000/0.3474258
A/H [1] = 0.0000000/0.5211387
A/H [2] = 0.3005652/0.0457515
A/H [3] = 0.0395806/0.0457515
A/H [4] = 0.0395806/0.0000000
A/H [5] = 0.0395806/0.0000000
A/H [6] = 0.0395806/0.0000000
A/H [7] = 0.3005652/0.0000000
A/H [8] = 0.3005652/0.6948516
A/H [9] = 0.6011303/0.3474258
A/H [10] = 0.6011303/0.0000000

Iter: 7 :
A/H [0] = 0.0000000/0.3478305
A/H [1] = 0.0000000/0.5217458
A/H [2] = 0.3010897/0.0305366
A/H [3] = 0.0264331/0.0305366
A/H [4] = 0.0264331/0.0000000
A/H [5] = 0.0264331/0.0000000
A/H [6] = 0.0264331/0.0000000
A/H [7] = 0.3010897/0.0000000
A/H [8] = 0.3010897/0.6956610
A/H [9] = 0.6021794/0.3478305
A/H [10] = 0.6021794/0.0000000

Iter: 8 :
A/H [0] = 0.0000000/0.3480108
A/H [1] = 0.0000000/0.5220163
A/H [2] = 0.3013237/0.0203683
A/H [3] = 0.0176358/0.0203683
A/H [4] = 0.0176358/0.0000000
A/H [5] = 0.0176358/0.0000000
A/H [6] = 0.0176358/0.0000000
A/H [7] = 0.3013237/0.0000000
A/H [8] = 0.3013237/0.6960217
A/H [9] = 0.6026475/0.3480108
A/H [10] = 0.6026475/0.0000000

Iter: 9 :
A/H [0] = 0.0000000/0.3480911
A/H [1] = 0.0000000/0.5221366
A/H [2] = 0.3014279/0.0135820
```

```
Iter: 9 :
A/H [0] = 0.0000000/0.3480911
A/H [1] = 0.0000000/0.5221366
A/H [2] = 0.3014279/0.0135820
A/H [3] = 0.0117612/0.0135820
A/H [4] = 0.0117612/0.0000000
A/H [5] = 0.0117612/0.0000000
A/H [6] = 0.0117612/0.0000000
A/H [7] = 0.3014279/0.0000000
A/H [8] = 0.3014279/0.6961822
A/H [9] = 0.6028558/0.3480911
A/H [10] = 0.6028558/0.0000000

Iter: 10 :
A/H [0] = 0.0000000/0.3481268
A/H [1] = 0.0000000/0.5221901
A/H [2] = 0.3014743/0.0090556
A/H [3] = 0.0078420/0.0090556
A/H [4] = 0.0078420/0.0000000
A/H [5] = 0.0078420/0.0000000
A/H [6] = 0.0078420/0.0000000
A/H [7] = 0.3014743/0.0000000
A/H [8] = 0.3014743/0.6962535
A/H [9] = 0.6029485/0.3481268
A/H [10] = 0.6029485/0.0000000

Iter: 11 :
A/H [0] = 0.0000000/0.3481426
A/H [1] = 0.0000000/0.5222139
A/H [2] = 0.3014949/0.0060373
A/H [3] = 0.0052284/0.0060373
A/H [4] = 0.0052284/0.0000000
A/H [5] = 0.0052284/0.0000000
A/H [6] = 0.0052284/0.0000000
A/H [7] = 0.3014949/0.0000000
A/H [8] = 0.3014949/0.6962852
A/H [9] = 0.6029897/0.3481426
A/H [10] = 0.6029897/0.0000000

Iter: 12 :
A/H [0] = 0.0000000/0.3481497
A/H [1] = 0.0000000/0.5222245
A/H [2] = 0.3015040/0.0040250
```

```
Iter: 12 :
A/H [0] = 0.0000000/0.3481497
A/H [1] = 0.0000000/0.5222245
A/H [2] = 0.3015040/0.0040250
A/H [3] = 0.0034857/0.0040250
A/H [4] = 0.0034857/0.0000000
A/H [5] = 0.0034857/0.0000000
A/H [6] = 0.0034857/0.0000000
A/H [7] = 0.3015040/0.0000000
A/H [8] = 0.3015040/0.6962993
A/H [9] = 0.6030080/0.3481497
A/H [10] = 0.6030080/0.0000000

Iter: 13 :
A/H [0] = 0.0000000/0.3481528
A/H [1] = 0.0000000/0.5222292
A/H [2] = 0.3015081/0.0026833
A/H [3] = 0.0023238/0.0026833
A/H [4] = 0.0023238/0.0000000
A/H [5] = 0.0023238/0.0000000
A/H [6] = 0.0023238/0.0000000
A/H [7] = 0.3015081/0.0000000
A/H [8] = 0.3015081/0.6963056
A/H [9] = 0.6030162/0.3481528
A/H [10] = 0.6030162/0.0000000

Iter: 14 :
A/H [0] = 0.0000000/0.3481542
A/H [1] = 0.0000000/0.5222313
A/H [2] = 0.3015099/0.0017889
A/H [3] = 0.0015492/0.0017889
A/H [4] = 0.0015492/0.0000000
A/H [5] = 0.0015492/0.0000000
A/H [6] = 0.0015492/0.0000000
A/H [7] = 0.3015099/0.0000000
A/H [8] = 0.3015099/0.6963084
A/H [9] = 0.6030198/0.3481542
A/H [10] = 0.6030198/0.0000000

Iter: 15 :
A/H [0] = 0.0000000/0.3481548
A/H [1] = 0.0000000/0.5222322
A/H [2] = 0.3015107/0.0011926
```

```
Iter: 15 :
A/H [0] = 0.0000000/0.3481548
A/H [1] = 0.0000000/0.5222322
A/H [2] = 0.3015107/0.0011926
A/H [3] = 0.0010328/0.0011926
A/H [4] = 0.0010328/0.0000000
A/H [5] = 0.0010328/0.0000000
A/H [6] = 0.0010328/0.0000000
A/H [7] = 0.3015107/0.0000000
A/H [8] = 0.3015107/0.6963096
A/H [9] = 0.6030214/0.3481548
A/H [10] = 0.6030214/0.0000000

Iter: 16 :
A/H [0] = 0.0000000/0.3481551
A/H [1] = 0.0000000/0.5222326
A/H [2] = 0.3015111/0.0007951
A/H [3] = 0.0006885/0.0007951
A/H [4] = 0.0006885/0.0000000
A/H [5] = 0.0006885/0.0000000
A/H [6] = 0.0006885/0.0000000
A/H [7] = 0.3015111/0.0000000
A/H [8] = 0.3015111/0.6963102
A/H [9] = 0.6030221/0.3481551
A/H [10] = 0.6030221/0.0000000

Iter: 17 :
A/H [0] = 0.0000000/0.3481552
A/H [1] = 0.0000000/0.5222328
A/H [2] = 0.3015112/0.0005300
A/H [3] = 0.0004590/0.0005300
A/H [4] = 0.0004590/0.0000000
A/H [5] = 0.0004590/0.0000000
A/H [6] = 0.0004590/0.0000000
A/H [7] = 0.3015112/0.0000000
A/H [8] = 0.3015112/0.6963104
A/H [9] = 0.6030224/0.3481552
A/H [10] = 0.6030224/0.0000000

Iter: 18 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222329
A/H [2] = 0.3015113/0.0003534
```

```
Iter: 18 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222329
A/H [2] = 0.3015113/0.0003534
A/H [3] = 0.0003060/0.0003534
A/H [4] = 0.0003060/0.0000000
A/H [5] = 0.0003060/0.0000000
A/H [6] = 0.0003060/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963105
A/H [9] = 0.6030226/0.3481553
A/H [10] = 0.6030226/0.0000000

Iter: 19 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222329
A/H [2] = 0.3015113/0.0002356
A/H [3] = 0.0002040/0.0002356
A/H [4] = 0.0002040/0.0000000
A/H [5] = 0.0002040/0.0000000
A/H [6] = 0.0002040/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030226/0.3481553
A/H [10] = 0.6030226/0.0000000

Iter: 20 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0001571
A/H [3] = 0.0001360/0.0001571
A/H [4] = 0.0001360/0.0000000
A/H [5] = 0.0001360/0.0000000
A/H [6] = 0.0001360/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000

Iter: 21 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0001047
```

```
Iter: 21 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0001047
A/H [3] = 0.0000907/0.0001047
A/H [4] = 0.0000907/0.0000000
A/H [5] = 0.0000907/0.0000000
A/H [6] = 0.0000907/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000

Iter: 22 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0000698
A/H [3] = 0.0000604/0.0000698
A/H [4] = 0.0000604/0.0000000
A/H [5] = 0.0000604/0.0000000
A/H [6] = 0.0000604/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000

Iter: 23 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0000465
A/H [3] = 0.0000403/0.0000465
A/H [4] = 0.0000403/0.0000000
A/H [5] = 0.0000403/0.0000000
A/H [6] = 0.0000403/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000

Iter: 24 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0000310
```

```
Iter: 24 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0000310
A/H [3] = 0.0000269/0.0000310
A/H [4] = 0.0000269/0.0000000
A/H [5] = 0.0000269/0.0000000
A/H [6] = 0.0000269/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000

Iter: 25 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0000207
A/H [3] = 0.0000179/0.0000207
A/H [4] = 0.0000179/0.0000000
A/H [5] = 0.0000179/0.0000000
A/H [6] = 0.0000179/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000

Iter: 26 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0000138
A/H [3] = 0.0000119/0.0000138
A/H [4] = 0.0000119/0.0000000
A/H [5] = 0.0000119/0.0000000
A/H [6] = 0.0000119/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000
Iter: 27 :
A/H [0] = 0.0000000/0.3481553
A/H [1] = 0.0000000/0.5222330
A/H [2] = 0.3015113/0.0000092
A/H [3] = 0.0000080/0.0000092
A/H [4] = 0.0000080/0.0000000
A/H [5] = 0.0000080/0.0000000
A/H [6] = 0.0000080/0.0000000
A/H [7] = 0.3015113/0.0000000
A/H [8] = 0.3015113/0.6963106
A/H [9] = 0.6030227/0.3481553
A/H [10] = 0.6030227/0.0000000
```

Sample Graph.txt

```
11 11
1 2
2 3
2 6
3 4
3 5
1 7
1 8
8 9
8 10
9 10
0 9
```

HITS Algorithm Implementation

```
                    /* HITS_8357.java*/
import static java.lang.System.*;
import java.util.*;
import java.io.*;
import java.text.DecimalFormat;
class hits_8357{
  public static void main(String[] args) throws Exception {
    int vertices=0, edges = 0;
    int count_iter = 0;
    DecimalFormat a = new DecimalFormat("0.0000000");
    int firstval = 0;
    int iter= 0;
    double rateoferr = 0.0;
    String graphtext = "";
    System.out.println(" \n \t \t \t HITS for  8357 \n");
    if (args.length != 3){
      System.out.println("Less number of arguments: Format is : hits_8357 interations firstval graphtext'");
      return;
    }
    for (int i=0;i<args.length;i++) {
      iter = Integer.parseInt(args[0]); //parsing the iteration value
      firstval = Integer.parseInt(args[1]); //parsing the initial value
      graphtext = args[2]; // parsing the sample graph text file name
    }
    if (!(firstval >= -2 && firstval <= 1)){
      System.out.println("First values not between -2, -1, 0 or 1");
      return;
    }
    Scanner scanner = new Scanner(new File(graphtext));  // reading sample graph
    vertices = scanner.nextInt();
    edges = scanner.nextInt();
    double graph[][] = new double[vertices][vertices];// initializing and representing the graph as an adjacency matrix
    for(int i = 0; i < vertices; i++){
      for(int j = 0; j < vertices; j++){
          graph[i][j] = 0.0;
      }
    }
    while(scanner.hasNextInt()){
      graph[scanner.nextInt()][scanner.nextInt()] = 1.0;
    }
    if (iter < 0){  //if number of iteration is negative it sets the rate of error
      rateoferr = Math.pow(10, iter);
    }
    double initial_authority[][] = new double[vertices][1];
```

```
45      double authority[][]= new double[vertices][1];
46      double authority_previous[][] = new double [vertices][1];
47      double authority_sum = 0.0;
48      double scaler_for_authority = 0;
49      double initial_hub[][] = new double[vertices][1];
50      double hub[][] = new double[vertices][1];
51      double hub_previous [][] = new double [vertices][1];
52      double scaler_for_hub = 0;
53      double hub_sum = 0.0;
54      double transpose_graph[][] = new double[vertices][vertices];
55
56      for(int i=0;i<vertices;i++){ //to calculate Transpose of Graph.
57        for(int j=0; j<vertices; j++){
58          transpose_graph[i][j] = graph[j][i];
59        }
60      }
61      if (vertices < 10){ //using switch case to initialize value of Authority and Hub if Vertices less than 10
62        switch(firstval){
63          case 0:
64            for(int i=0; i<vertices; i++){
65              for(int j=0; j<1; j++){
66                initial_authority[i][j] = 0.0;
67                initial_hub[i][j] = 0.0;
68              }
69            }
70            break;
71            case 1:
72            for(int i=0; i<vertices; i++){
73              for(int j=0; j<1; j++){
74                initial_authority[i][j] = 1.0;
75                initial_hub[i][j] = 1.0;
76              }
77            }
78            break;
79            case -1:
80            for(int i=0; i<vertices; i++){
81              for(int j=0; j<1; j++){
82                initial_authority[i][j] = 1.0/vertices;
83                initial_hub[i][j] = 1.0/vertices;
84              }
85            }
86            break;
87            case -2:
88            for(int i=0; i<vertices; i++){
```

```
            for(int j=0; j<1; j++){
              initial_authority[i][j] = 1.0/Math.sqrt(vertices);
              initial_hub[i][j] = 1.0/Math.sqrt(vertices);
            }
          }
          break;
      }
    }
    else {    //else if vertices is greater than 10
      iter = 0;
      firstval = -1;
      rateoferr = 0.00001;
      for(int i=0; i<vertices; i++){
        for(int j=0; j<1; j++){
          initial_authority[i][j] = 1.0/vertices;
          initial_hub[i][j] = 1.0/vertices;
        }
      }
    }
    for (int i=0; i<vertices; i++){     //it will Calculate Base Case of Hub.
      for (int j=0; j<1; j++){
        for (int k=0; k<vertices; k++){
          authority_sum = authority_sum + transpose_graph[i][k]*initial_hub[k][j];
        }
        authority[i][j] = authority_sum;
        authority_sum = 0;
      }
    }
    for (int i=0; i<vertices; i++){
      for (int j=0; j<1; j++){
        for (int k=0; k<vertices; k++){
          hub_sum = hub_sum + graph[i][k]*authority[k][j];     //it will Calculate for the Base Case of Authority
        }
        hub[i][j] = hub_sum;
        hub_sum = 0;
      }
    }
    for (int i=0; i<vertices; i++ ){
      for (int j=0; j<1; j++){
        authority_sum = authority_sum+ (authority[i][j]*authority[i][j]); //it will calculate Authority Sum Sqaure
      }
    }
    for (int i=0; i<vertices; i++ ){
      for (int j=0; j<1; j++){
```

```
    for (int j=0; j<1; j++){
      hub_sum = hub_sum + (hub[i][j]*hub[i][j]); //it will calculate Hub Sum Square
    }
  }
  System.out.print("Base: " +count_iter + " : ");
  if (vertices > 5){
    System.out.println();
  }
  for(int i=0; i<vertices; i++){
    for(int j=0; j<1; j++){
      System.out.print("A/H [" + i + "] = " + a.format(initial_authority[i][j]) + "/" + a.format(initial_hub[i][j]) + " ");
      if (vertices > 5){
        System.out.println();
      }
    }
  }
  System.out.println();
  if(iter > 0){  // till iterations is 0 it will calculate authority and hub values
    while (iter != 0){
      System.out.print("Iter: " + (count_iter+1) + " :  ");
      if (vertices > 5){
        System.out.println();
      }
      for (int i=0; i<vertices; i++){
        for (int j=0; j<1; j++){
          scaler_for_authority = Math.sqrt(authority_sum);
          scaler_for_hub = Math.sqrt(hub_sum);
          authority[i][j] = authority[i][j]/scaler_for_authority;
          hub[i][j] = hub[i][j]/scaler_for_hub;
          System.out.print(" A/H [" + i + "] = " + a.format(authority[i][j]) + "/" + a.format(hub[i][j]) + " ");
          if (vertices > 5){
            System.out.println();
          }
        }
      }
      authority_sum = 0;
      hub_sum = 0;           //it will Calculate authority and hub value till iteration = 0
      for (int i=0; i<vertices; i++){
        for (int j=0; j<1; j++){
          for (int k=0; k<vertices; k++){
            authority_sum = authority_sum + transpose_graph[i][k]*hub[k][j];
          }
          authority[i][j] = authority_sum;
          authority_sum = 0;
```

```
175           authority_sum = 0;
176         }
177       }
178       for (int p=0; p<vertices; p++){
179         for (int q=0; q<1; q++){
180           for (int r=0; r<vertices; r++){
181             hub_sum = hub_sum + graph[p][r]*authority[r][q];
182           }
183           hub[p][q] = hub_sum;
184           hub_sum = 0;
185         }
186       }
187       for (int s=0; s<vertices; s++ ){
188         for (int t=0; t<1; t++){
189           authority_sum = authority_sum+ (authority[s][t]*authority[s][t]);
190         }
191       }
192       for (int x=0; x<vertices; x++ ){
193         for (int y=0; y<1; y++){
194           hub_sum = hub_sum + (hub[x][y]*hub[x][y]);
195         }
196       }
197       System.out.println();
198       iter = iter - 1;
199       count_iter++;
200     }
201   }
202   else{
203     do {
204       for (int i = 0; i<vertices; i++){
205         for (int j = 0; j<1; j++){
206           authority_previous[i][j] = authority[i][j];
207           hub_previous[i][j] = hub[i][j];
208         }
209       }
210       System.out.print("Iter: " + (count_iter+1) + " : ");
211       if (vertices > 5){
212         System.out.println();
213       }
214       for (int i=0; i<vertices; i++){
215         for (int j=0; j<1; j++){
216           scaler_for_authority = Math.sqrt(authority_sum);
217           scaler_for_hub = Math.sqrt(hub_sum);
218           authority[i][j] = authority[i][j]/scaler_for_authority;
```

```
        authority[i][j] = authority[i][j]/scaler_for_authority;
        hub[i][j] = hub[i][j]/scaler_for_hub;
        System.out.print("A/H [" + i + "] = " + a.format(authority[i][j]) + "/" + a.format(hub[i][j]) + " ");
        if (vertices > 5){
          System.out.println();
        }
      }
    }
    authority_sum = 0; // It will calculate authority and hub value until convergence is achieved
    hub_sum = 0;
    for (int i=0; i<vertices; i++){
      for (int j=0; j<1; j++){
        for (int k=0; k<vertices; k++){
          authority_sum = authority_sum + transpose_graph[i][k]*hub[k][j];
        }
        authority[i][j] = authority_sum;
        authority_sum = 0;
      }
    }
    for (int p=0; p<vertices; p++){
      for (int q=0; q<1; q++){
        for (int r=0; r<vertices; r++){
          hub_sum = hub_sum + graph[p][r]*authority[r][q];
        }
        hub[p][q] = hub_sum;
        hub_sum = 0;
      }
    }
    for (int s=0; s<vertices; s++ ){
      for (int t=0; t<1; t++){
        authority_sum = authority_sum+ (authority[s][t]*authority[s][t]);
      }
    }
    for (int x=0; x<vertices; x++ ){
      for (int y=0; y<1; y++){
        hub_sum = hub_sum + (hub[x][y]*hub[x][y]);
      }
    }
    System.out.println();
    count_iter++;
  } while (false == CheckConverge8357(authority, authority_previous, vertices, rateoferr) || false == CheckConverge8357(hub, hub_previous, vertices,rateoferr));
 }
}
public static boolean CheckConverge8357(double initial[][], double previous[][], int n, double rateoferr){ // convergence function
    for(int i = 0 ; i < n; i++){
      for (int j = 0; j < 1; j++){
        if ( Math.abs(initial[i][j] - previous[i][j]) > rateoferr )
          return false;
      }
    }
    return true;
 }
}
```

Problems Occurred:

Since in the first implementation of root and neighbourhood graphs, due to some errors that were showing the hits was not able to implement.

So, tried to implement the HITS algorithm using a sample graph and tried to implement it .

THANKYOU