Finolex Academy of Management and Technology, Ratnagiri

Department of Information Technology

Subject name: Big Data Analytics				Subject Code: ITC801
Class	BE IT	Semester – VIII (CBGS)		Academic year: 2019-20
Name of Student	**Kazi Jawwad A Rahim**		**QUIZ Score :**	
Roll No	**28**	Assignment/Experiment No.		08

Title: **Implementation of HITS Algorithm**

1. Course objectives applicable: **COB4**.Study Page Rank in Link Analysis and concepts of Handling larger datasets

2. Course outcomes applicable:
CO4-Implement use of combiners to consolidate results and ability to handle larger datasets

3. Learning Objectives:

1. To understand concept of HITS
2. To understand Hubs and Authorities
3. To program HITS Score computation in C/C++
4. To prove that HITS Converges after certain iterations

4. Practical applications of the assignment/experiment: HITS Algorithm is used by Ask.com Search engine for indexing of webpages and giving results for search queries

5. Prerequisites:

1. Understanding of Internet Technologies

6. Hardware Requirements:

1. PC with 4GB RAM, 500GB HDD,

7. Software Requirements:

1. Access to C/C++ compiler
2. Internet access if online compiler is used

8. Quiz Questions (if any): (Online Exam will be taken separately batchwise, attach the certificate/ Marks obtained)

1. What is a HITS?
2. What is HUB?
3. What is a Authority Page?
4. What is SCC?

9. Experiment/Assignment Evaluation:

Sr. No.	**Parameters**	**Marks obtained**	**Out of**
1	Technical Understanding (Assessment may be done based on Q & A **or** any other relevant method.) Teacher should mention the other method used -		6
2	Neatness/presentation		2
3	Punctuality		2

Date of performance (DOP)		**Total marks obtained**		**10**
Date of checking (DOC)		**Signature of teacher**		

12. Installation Steps / Performance Steps –

PageRank Program with Teleportation:

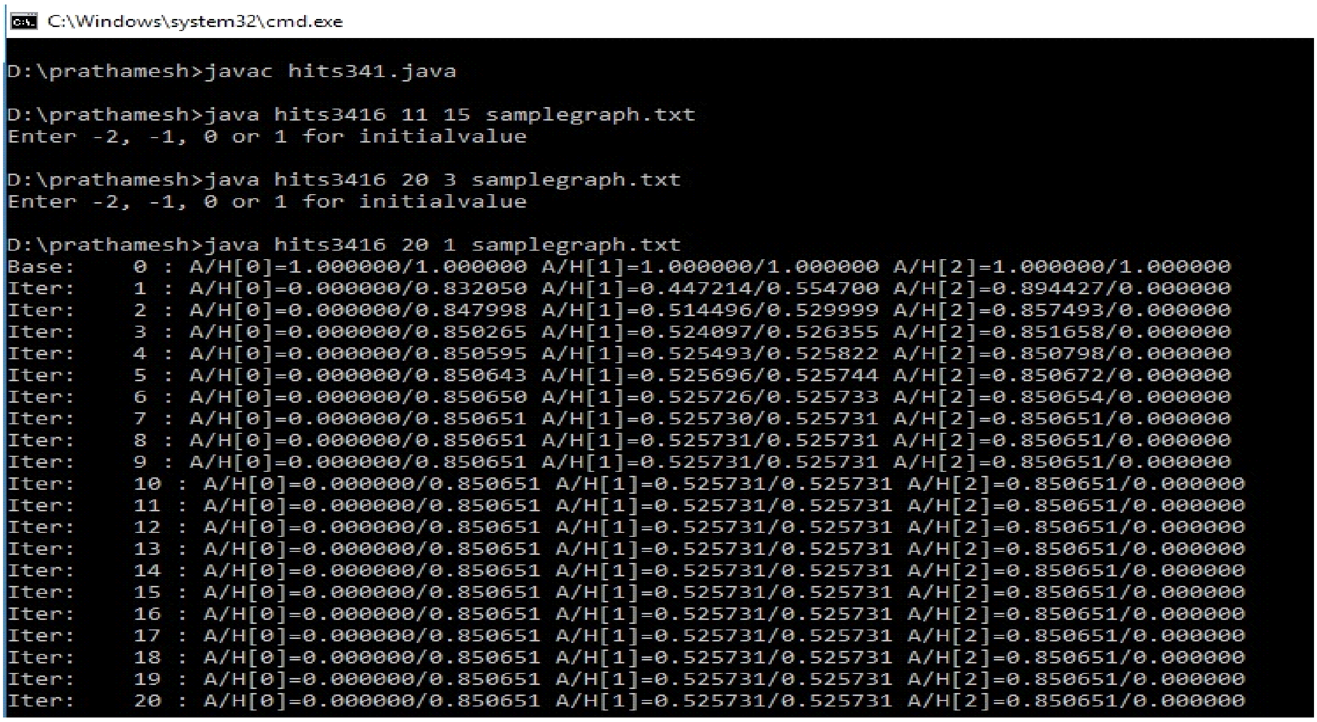
```
import java.util.*;
import java.io.*;
import java.lang.*;
import static java.lang.Math.*;
public class hits341 {
        int iter;
        int initval;
        String filename;
        int n;      // number of vertices in the graph
        int m;      // number of edges in the graph
        int[][] L;  // adjacency matrix
        double[] h0;
        double[] a0;
        final double errorrate = 0.00001;
    hits341() {} //default constructor
    hits341(int iter, int initval, String filename)     // 3 argument constructor to initialize class variables with provided command line arguments
    {
        this.iter = iter;
        this.initval = initval;
        this.filename = filename;
        try {
            Scanner scanner = new Scanner(new File(filename));
            n = scanner.nextInt();
            m = scanner.nextInt();
            //System.out.println("n = " + n + " m = " + m);
            //Adjacency matrix representation of graph
            L = new int[n][n];
            for(int i = 0; i < n; i++)
             for(int j = 0; j < n; j++)
                          L[i][j] = 0;
            while(scanner.hasNextInt())
            {
                L[scanner.nextInt()][scanner.nextInt()] = 1;
                //System.out.println(scanner.nextInt());
            }
            h0 = new double[n];
            a0 = new double[n];
            switch(initval) {
            case 0:
              for(int i = 0; i < n; i++) {
                h0[i] = 0;
                a0[i] = 0;
              }
              break;
            case 1:
              for(int i = 0; i < n; i++) {
                h0[i] = 1;
                a0[i] = 1;
              }
              break;
            case -1:
              for(int i =0; i < n; i++) {
                h0[i] = 1.0/n;
                a0[i] = 1.0/n;
              }
              break;
            case -2:
              for(int i =0; i < n; i++) {
                h0[i] = 1.0/Math.sqrt(n);
                a0[i] = 1.0/Math.sqrt(n);
              }
              break;
            }
        }
        catch(FileNotFoundException fnfe){}
    }

    public static void main(String[] args)
    {
        if(args.length != 3) {
            System.out.println("Usage: hits3416 iterations initialvalue filename");
            return;
        }
        //command line arguments
        int iterations = Integer.parseInt(args[0]);
        int initialvalue = Integer.parseInt(args[1]);
        String filename = args[2];
        if( !(initialvalue >= -2 && initialvalue <= 1) ) {
            System.out.println("Enter -2, -1, 0 or 1 for initialvalue");
            return;
        }
        hits3416 ht = new hits3416(iterations, initialvalue, filename);
        ht.hitsAlgo3416();
    }
 boolean isConverged(double[] p, double[] q)
    {
       for(int i = 0 ; i < n; i++) {
           if ( abs(p[i] - q[i]) > errorrate )
             return false;
       }
       return true;
    }

    public void hitsAlgo3416()
    {
        double[] h = new double[n];
        double[] a = new double[n];
        double a_scale_factor = 0.0;
        double a_sum_square = 0.0;
        double h_scale_factor = 0.0;
        double h_sum_square = 0.0;
        double[] aprev = new double[n]; //last iterations values of a, used for convergence
        double[] hprev = new double[n]; //last iterations values of h, used for convergence
        //If the graph has N greater than 10, then the values for iterations, initialvalue revert to 0 and -1
respectively
        if(n > 10) {
            iter = 0;
            for(int i =0; i < n; i++) {
                h[i] = 1.0/n;
                a[i] = 1.0/n;
                hprev[i] = h[i];
                aprev[i] = a[i];
            }
          int i = 0;
          do {
              for(int r = 0; r < n; r++) {
                    aprev[r] = a[r];
                    hprev[r] = h[r];
                }
                //A step starts
                for(int p = 0; p < n; p++) {
                    a[p] = 0.0;
                }
                for(int j = 0; j < n; j++) {
                    for(int k = 0; k < n; k++) {
                        if(L[k][j] == 1) {
                            a[j] += h[k];
                        }
                    }
                }//A step ends
                //H step starts
                for(int p = 0; p < n; p++) {
                    h[p] = 0.0;
                }
                for(int j = 0; j < n; j++) {
                    for(int k = 0; k < n; k++) {
                        if(L[j][k] == 1) {
                            h[j] += a[k];
                        }
                    }
                }//H step ends
                //Scaling A starts
                a_scale_factor = 0.0;
                a_sum_square = 0.0;
                for(int l = 0; l < n; l++) {
                    a_sum_square += a[l]*a[l];
                }
                a_scale_factor = Math.sqrt(a_sum_square);
                for(int l = 0; l < n; l++) {
                    a[l] = a[l]/a_scale_factor;
                }//Scaling A ends
                //Scaling H starts
                h_scale_factor = 0.0;
                h_sum_square = 0.0;
                for(int l = 0; l < n; l++) {
                    h_sum_square += h[l]*h[l];
                }
                h_scale_factor = Math.sqrt(h_sum_square);
                for(int l = 0; l < n; l++) {
                    h[l] = h[l]/h_scale_factor;
                }// Scaling H ends
                i++; // incr the interation counter
          } while( false == isConverged(a, aprev) || false == isConverged(h, hprev));
          System.out.println("Iter:    " + i);
          for(int l = 0; l < n; l++) {
              System.out.printf("
A/H[%d]=%.6f/%.6f\n",l,Math.round(a[l]*1000000.0)/1000000.0,Math.round(h[l]*1000000.0)/1000000.0)
;
          }
          return;
        }
        //Initialization
        for(int i = 0; i < n; i++)
        {
            h[i] = h0[i];
            a[i] = a0[i];
            hprev[i] = h[i];
            aprev[i] = a[i];
        }

        //Base Case
        System.out.print("Base:    0 :");
        for(int i = 0; i < n; i++) {
          System.out.printf("
A/H[%d]=%.4f/%.4f",i,Math.round(a0[i]*1000000.0)/1000000.0,Math.round(h0[i]*1000000.0)/1000000.0)
;
          //System.out.println("a0[" + i + "]= " + a0[i]);
        }
        if (iter != 0) {
            for(int i = 0; i < iter; i++) { //iteration starts
                //A step starts
                for(int p = 0; p < n; p++) {
                    a[p] = 0.0;
                }
                for(int j = 0; j < n; j++) {
                    for(int k = 0; k < n; k++) {
                        if(L[k][j] == 1) {
                            a[j] += h[k];
                        }
                    }
                }//A step ends
              //H step starts
                for(int p = 0; p < n; p++) {
                    h[p] = 0.0;
                }
                for(int j = 0; j < n; j++) {
                    for(int k = 0; k < n; k++) {
                        if(L[j][k] == 1) {
                            h[j] += a[k];
                        }
                    }
                }//H step ends
                //Scaling A starts
                a_scale_factor = 0.0;
                a_sum_square = 0.0;
                for(int l = 0; l < n; l++) {
                    a_sum_square += a[l]*a[l];
                }
                a_scale_factor = Math.sqrt(a_sum_square);
                for(int l = 0; l < n; l++) {
                    a[l] = a[l]/a_scale_factor;
                }//Scaling A ends
                //Scaling H starts
                h_scale_factor = 0.0;
                h_sum_square = 0.0;
                for(int l = 0; l < n; l++) {
                    h_sum_square += h[l]*h[l];
                }
                h_scale_factor = Math.sqrt(h_sum_square);
                for(int l = 0; l < n; l++) {
                    h[l] = h[l]/h_scale_factor;
                }// Scaling H ends
                System.out.println();
                System.out.print("Iter:    " + (i+1) + " :");
                for(int l = 0; l < n; l++) {
                    System.out.printf("
A/H[%d]=%.4f/%.4f",l,Math.round(a[l]*1000000.0)/1000000.0,Math.round(h[l]*1000000.0)/1000000.0);
                }
              }//iteration ends
          } // if iter != 0 ends
          else
          {
            int i = 0;
            do {
                for(int r = 0; r < n; r++) {
                    aprev[r] = a[r];
                    hprev[r] = h[r];
                }
                //A step starts
                for(int p = 0; p < n; p++) {
                    a[p] = 0.0;
                }
                for(int j = 0; j < n; j++) {
                    for(int k = 0; k < n; k++) {
                        if(L[k][j] == 1) {
                            a[j] += h[k];
                        }
                    }
                }//A step ends
                //H step starts
                for(int p = 0; p < n; p++) {
                    h[p] = 0.0;
                }
                for(int j = 0; j < n; j++) {
                    for(int k = 0; k < n; k++) {
                        if(L[j][k] == 1) {
                            h[j] += a[k];
                        }
                    }
                }//H step ends
                //Scaling A starts
                a_scale_factor = 0.0;
                a_sum_square = 0.0;
                for(int l = 0; l < n; l++) {
                    a_sum_square += a[l]*a[l];
                }
                a_scale_factor = Math.sqrt(a_sum_square);
                for(int l = 0; l < n; l++) {
                    a[l] = a[l]/a_scale_factor;
                }//Scaling A ends
                //Scaling H starts
                h_scale_factor = 0.0;
                h_sum_square = 0.0;
                for(int l = 0; l < n; l++) {
                    h_sum_square += h[l]*h[l];
                }
                h_scale_factor = Math.sqrt(h_sum_square);
                for(int l = 0; l < n; l++) {
                    h[l] = h[l]/h_scale_factor;
                }// Scaling H ends
                i++; // incr the interation counter
                System.out.println();
                System.out.print("Iter:    " + i + " :");
                for(int l = 0; l < n; l++) {
                    System.out.printf("
A/H[%d]=%.4f/%.4f",l,Math.round(a[l]*1000000.0)/1000000.0,Math.round(h[l]*1000000.0)/1000000.0);
```

```
                }
            } while( false == isConverged(a, aprev) || false == isConverged(h, hprev));
          }
          System.out.println();
      }
}
```

13. Observations

1. The scores converged after 20 Iterations

14. Results:



```
D:\prathamesh>javac hits341.java

D:\prathamesh>java hits3416 11 15 samplegraph.txt
Enter -2, -1, 0 or 1 for initialvalue

D:\prathamesh>java hits3416 20 3 samplegraph.txt
Enter -2, -1, 0 or 1 for initialvalue

D:\prathamesh>java hits3416 20 1 samplegraph.txt
Base:    0 : A/H[0]=1.000000/1.000000 A/H[1]=1.000000/1.000000 A/H[2]=1.000000/1.000000
Iter:    1 : A/H[0]=0.000000/0.832050 A/H[1]=0.447214/0.554700 A/H[2]=0.894427/0.000000
Iter:    2 : A/H[0]=0.000000/0.847998 A/H[1]=0.514496/0.529999 A/H[2]=0.857493/0.000000
Iter:    3 : A/H[0]=0.000000/0.850265 A/H[1]=0.524097/0.526355 A/H[2]=0.851658/0.000000
Iter:    4 : A/H[0]=0.000000/0.850595 A/H[1]=0.525493/0.525822 A/H[2]=0.850798/0.000000
Iter:    5 : A/H[0]=0.000000/0.850643 A/H[1]=0.525696/0.525744 A/H[2]=0.850672/0.000000
Iter:    6 : A/H[0]=0.000000/0.850650 A/H[1]=0.525726/0.525733 A/H[2]=0.850654/0.000000
Iter:    7 : A/H[0]=0.000000/0.850651 A/H[1]=0.525730/0.525731 A/H[2]=0.850651/0.000000
Iter:    8 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    9 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    10 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    11 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    12 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    13 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    14 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    15 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    16 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    17 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    18 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    19 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
Iter:    20 : A/H[0]=0.000000/0.850651 A/H[1]=0.525731/0.525731 A/H[2]=0.850651/0.000000
```

References :

1. *Christopher D. Manning, Prabhakar Raghavan & Hinrich Schütze (2008). "Introduction to Information Retrieval". Cambridge University Press. Retrieved 2008-11-09.*
2. **Jump up^** *Kleinberg, Jon (December 1999). "Hubs, Authorities, and Communities". Cornell University. Retrieved 2008-11-09.*