# Mathematical and computer based Model of Web Page Ranking: AQuantitative Report on Programmatic Level of Approach

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**Abstract:**

In the recent past, the cyberspace has been increased to a great extent. Even the dependence of cyberspace has been increased. There are about 4.6 billion websites in the world wide web, but only about 200 million are active. Many of them begin their navigation using search engine. Search engines helps user to surf internet. Due to millions of webpages it very difficult for the user to choose the required website. And however user cannot go through each and every output page. Thus, these search engines use the page rank algorithm to determine the importance of webpage.

PageRank algorithm is used by search engines like Google, Bing etc. Here, the Page rank is named after Larry Page, Surgery Brin. PageRank can be considered as a measurement of importance of websites. This PageRank works as it counts the number of links and quality of the links to a webpage to predict the importance of a webpage. The main motto under this is that more important webpage likely receives more links from other webpages [1]. PageRank is not only the one which tells the importance of page but, it is one method among them. It can be said as let us assume a page A has S1 to Sn pages which are referred as incoming links to page A. Another parameter 'd' damping factor usually lies between 0 to 1. But 'd' can be considered as 0.85. and finally C(A) is taken as out bound links of page A". Therefore, PageRank of A can be given as

$$PR(A) = (1-d) + d(PR(S1)/C(S1).....PR(Sn)/C(Sn))$$ [2].

PageRank is the addition of a constant value (1-d=0.15) and addition of damped values of ratio of incoming to outbound of different pages. This PageRank is very similar to money management with different sectors. From fig (1), the sector which receives more donations has more money and vice versa, the PageRank algorithm works as the same the webpage which has more incoming links ranked more.

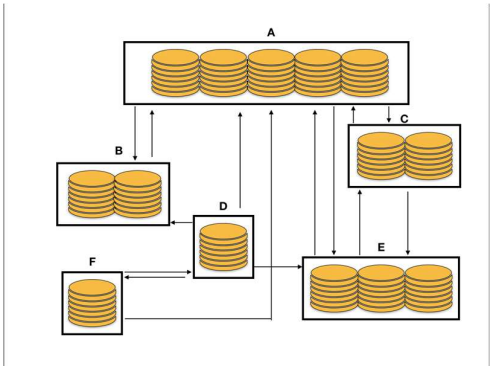



fig (1)

Thus, The PageRank algorithm helps the search engines and the users to retrieve the required webpage easily.

Keywords: PageRank, Search engine, web pages, links, algorithm, damping, C, C++, JAVA, Python, Programming Language, Matrices.

## Introduction

World Wide Web is the main vast resource that keeps the interlinked and different information like audio, video, text, and many other forms. It had been expanded 4000% since its evolution and it is becoming double for 3 to 5 months. So it is difficult to manage the information in

WWW. Search engines plays a major role in getting the required information from the WWW. These Search engines are listed and indexed millions of webpages. But whenever user requires a webpage the search engine displays the result, 60% - 70% of users may choose first resultant page and 20% - 30% may choose second resultant page and 2% - 3% users may choose third resultant page according to their query [3].

To show these results, Search engines follow some of the algorithms like PageRank algorithm.

*Ranking Algorithms*

Due to rapid increase of information in the WWW and accessing users the queries become more by the users. The search engines has to display the needed webpage according to the user's query. The search engines follow the algorithms to display the user required page by having some webpage ranking algorithms. some of them are listed below

- Link analysis algorithm
- Personalized web search ranking algorithm
- Page segmentation algorithm

*Link analysis algorithm*

When crawling information from web we may or may not get the desired webpage. Search engines are used to give the desired webpage to the user, but due to the vast amount of information the search engines may not provide required information or desired webpage to the user. So there must a need of algorithms to be adopted by the Search engines, one of its kind is Link analysis algorithm.

This analysis works by linking the webpages, the search engines produce the quality of results which are lower than expected by users [4]. So there must be some criteria to rank the pages.

*PageRank algorithm*

This PageRank algorithm is proposed by Surgey Brin and Larry page. Famous search engine GOOGLE uses this PageRank algorithm.

This became the heart of Google's search engine. The ranking to a webpage is given based on the importance of the page.

This PageRank counts the number of incoming links to one webpage, this process is recursive, since it does not depend on single page. here the webpages are taken as nodes and incoming links as edges so a webpage is ranked higher when it has more edges (incoming links) and considered as more important page, and the page with lesser edges (incoming links) is ranked lower.

Consider 4 web pages namely A, B, C and D. and incoming links of 4 pages are 5,3,6,1 respectively. When we apply PageRank algorithm it counts the number of incoming links here the page C has more number of incoming links so page C is given more importance and ranked higher.

*HITS*

Hyperlink Induced Topic Search is a link used for analyzing web rates introduced by john Kleinberg. HITS can also be known as hubs and authorities. A good hub represents a page that may be linked to many other pages. A good authority represented a page that is linked by many hubs[5].

The authority matrix can be obtained by $v=A^t * u$

The hub matrix can be obtained by $u= A * v$

Here A is the adjacency matrix of a network.

v is authority matrix, when calculating it u matrix is unity column matrix.

u is finally hub matrix used for calculating PageRank.

*Focused rank*

It is based on the linking between the different websites. Focused search points the particular topic needed by the user. Focused search addresses the multi dimensionality of www and relationship between the same content.

Consider two pages A and B which have hyperlink between them and a set of documents S and topics T then we have probability p(d, t) where d belongs to S and t belongs to T. the searched document d is a part of searched topic t. the topical overlap between these websites is low when they have some topics in common and topical overlap score for two webpages is given by

$$T(A,B)=\sum_{j\ni t} C_u(j)C_v(j)$$

the probability of surfing from page A to page B is function of similar topics of two pages forms a matrix is given by

$$M_{AB}=T(A,B)$$

and finally the probability function is

$$P_T(A \to B) \frac{T(A,B)}{\sum_{d \ni D} T(A,d)}$$

*Personalized web search ranking algorithm*

There is vast information present in internet this is sharing widely by using search engines to make use of information. But search engines are resulting useless data to the user. This happens because the search engine's return the keyword matched data which is not essential for the user [6]. Personalization is the process where search engine has to return the user's satisfied information. It involves mainly two processes one of them is two collect the user's interested data and should represent to the user. Second process may involve rearranging of ranks between the pages according to the user's interest.

*Page Segmentation algorithm*

Due to variation in the web pages like, length of page and several topics in a page it is necessary to make webpages into blocks [7]. This process of dividing into blocks increases the web search performance. The page segmentation algorithm is of mainly four types

- Fixed length page segmentation
- DOM based page segmentation
- Vision based page segmentation
- Combined approach segmentation

**Working:**

*Mathematical Approach:*

The web page ranking algorithm can be solved mathematically using matrices. The matrix is represented with help of the probability and the path between web pages [8]. These two are represented with help of outbound links from one web page to the other web page. The mathematical result is dependent on the damping factor which is previously set as 0.85[9]. The mathematical approach can be interpreted using a simple illustration of web pages. The example problem is represented in fig (3).

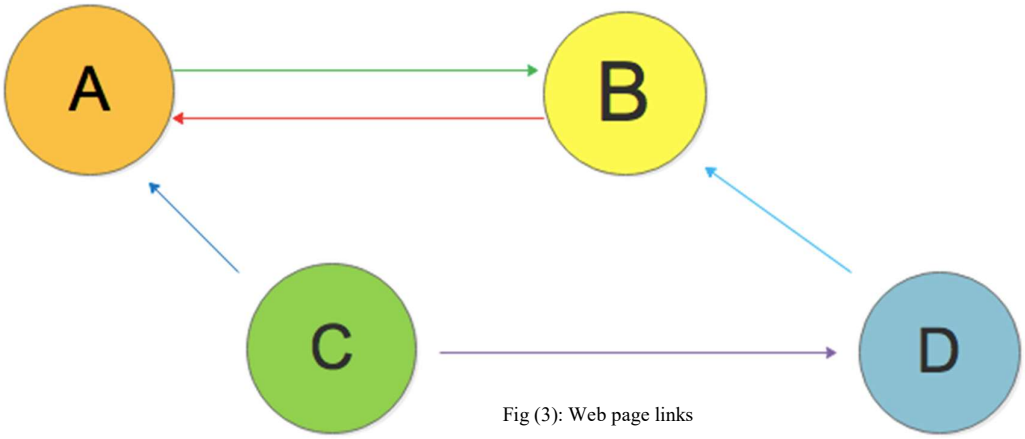



Fig (3): Web page links

As depicted in fig (3). The out bound link from A is only 1 i.e. link to B, the out bound link from B is also 1 i.e. link to A, the out bound links from C is 2 i.e. links to A and D, the out bound link from D is only 1 i.e. link to B. As per random surfer method web page ranking is determined by using probability of web pages, this probability is based on the out bound links in simple terms it can explained as the probability of acquiring a head while tossing a coin is 0.5 it is given as ratio of total probability to number of chances [10]. It is known that total probability of is always equal to 1. In the case of web page ranking the probability of each path is determined by the ratio of 1 to the number of out bound links from that page. From fig (3) the probability of path from A to B is given as 1, the probability of path from B to A is given as 1, the probability of path from D to B is given as 1, probability from C to A is 0.5, and from C to D is 0.5. The following resultant probability paths are represented in matrix format which are later multiplied with column matrix of damping factor whose number of rows is dependent on number of pages in the example case the total number of web pages is 4 so the damping factor matrix is a column matrix with 4 rows where

every element has the value of 0.85. For simplification, let us assume the path matrix to be M [4][4] which is 4X4 matrix where the probability matrix to be N [4][4] which is also a 4X4 matrix. Let the damping factor matrix be V [4][1] which is 4X1 matrix. To end up with the result we need to find the transpose of a matrix N [4][4] which is assumed to be N' [4][4]. This transposed matrix is multiplied with damping factor V [4][1] this results in page rank matrix of given web page conditions it is considered to be Q [4][1] this complete process is of iteration 1 if we need 2nd iteration we need to multiply N' [4][4] with Q [4][1] which will result in another matrix i.e. R [4][1]. This process is continued for prescribed iterations.

Solution:

Arranging the path of the web pages in matrix format

M =

| | A | B | C | D |
|---|---|---|---|---|
| A | 0 | 1 | 0 | 0 |
| B | 1 | 0 | 0 | 0 |
| C | 1 | 0 | 0 | 1 |
| D | 0 | 1 | 0 | 0 |

Arranging the probability matrix

N =

| | A | B | C | D |
|---|---|---|---|---|
| A | 0.0 | 1.0 | 0.0 | 0.0 |
| B | 1.0 | 0.0 | 0.0 | 0.0 |
| C | 0.5 | 0.0 | 0.0 | 0.5 |
| D | 0 | 1 | 0 | 0 |

Transpose of N is given as

N' =

| | A | B | C | D |
|---|---|---|---|---|
| A | 0.0 | 1.0 | 0.5 | 0.0 |
| B | 1.0 | 0.0 | 0.0 | 1.0 |
| C | 0.0 | 0.0 | 0.0 | 0.0 |
| D | 0.0 | 0.0 | 0.5 | 0.0 |

The damping factor matrix is given as

V =

| |
|---|
| 0.85 |
| 0.85 |
| 0.85 |
| 0.85 |

The page rank matrix is given as the dot product of N' and V

Q =

| | A | B | C | D |
|---|---|---|---|---|
| A | 0.0 | 1.0 | 0.5 | 0.0 |
| B | 1.0 | 0.0 | 0.0 | 1.0 |
| C | 0.0 | 0.0 | 0.0 | 0.0 |
| D | 0.0 | 0.0 | 0.5 | 0.0 |

.

| |
|---|
| 0.85 |
| 0.85 |
| 0.85 |
| 0.85 |

Q =

| |
|---|
| 1.275 |
| 1.7 |
| 0.00 |
| 0.425 |

The matrix Q gives the page rank matrix which can be interfered as following:

The rank of web page A is 1.275

The rank of web page B is 1.7

The rank of web page C is 0.0

The rank of web page D is 0.425

Hence, web page ranking algorithm can be solved by mathematical approach.

*Programmatic level of approach:*

The same can be solved using programming languages, now-a-days it is well known that programming language is the master of development and easiest approach to get the solution [11]. It needs no requirement of understanding the concept behind the process or problem to evaluate it. Whereas mathematical approach needs complete understanding of concept to evaluate it, it even requires command on matrices to solve them. Programming languages operates according to the program they take input from user to show up the result. The same program is used to manipulate millions of inputs and it does not require much time to evaluate any problem. They are accurate, precise and quick compared to mathematic approach we can completely rely on the code to exhibit the results. Programs are the code which are evaluated to perform a specific task, the language which is used to write a program is known as programming language. The well-known and buzzing programming languages in the present world are C, C++, JAVA, and PYTHON [12]. The process of operation is different in every language but the result is same which has to print the Page rank of a matrix. We made use of these four programming languages to print the page rank of matrix by taking the input from user. We compared the results of every language in terms of execution time, number of lines of code, size occupied by the files. All the programs are executed in the Apple MacBook Air whose details are mentioned in fig (4)


fig (4): System Properties

Program in C- Language:

C is one of the high level language which was developed by Dennis Ritchie it has some beneficial features like sequential programming, structured programming language, easy to learn, simple syntax's [13]. We performed matrix operations using multidimensional arrays and arrived at the solution the result is accurate and quick. This requires little large space compared to other languages. The input given by the user is taken and stored in arrays using "for loop" which continues till the failure of condition. The iterations are managed with help of switch statements. The program is given below. The output is given in fig (5).

```
#include<stdio.h>
#include<time.h>
int main()
{
int iteration,page[50],n,i,j,k;
float N[50][50], M[50][50], N1[50][50],
V[50][50],Q[50][50],R[50][50],S[50][50],
sum=0;
printf("enter how many iterations do you
want for page rank: \n");
scanf("%d", &iteration);
printf("Enter number of web pages: \n");
scanf("%d",&n);
for(i=0;i<n;i++)
{
printf("Number of out bound links for web
page rank %d",i+1);
scanf("%d", &page[i]);
}
printf("Enter path of web pages (outbounds)
if path is present enter 1 else 0\n");
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
scanf("%f",&M[i][j]);
}
}
clock_t start = clock();
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
N[i][j]= M[i][j]/page[i];
}
}
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
N1[j][i] = N[i][j];
}
}
for(i=0;i<n;i++)
{
V[i][0]= 0.85;
}
```

```
switch (iteration)
{
case 1: for(i=0;i<n;i++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*V[k][0];
}
Q[i][0] = sum;
sum=0;
}
for(i=0;i<n;i++)
{
printf("PAGE RANK OF PAGE %d is
%f\n", i+1, Q[i][0]);
}
break;
case 2: for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*V[k][j];
}
Q[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[I][k]*Q[k][j];
}
R[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
printf("PAGE RANK OF PAGE %d is
%f\n", i+1, R[i][j]);
}
}
break;
case 3: for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*V[k][j];
}
Q[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[I][k]*Q[k][j];
}
R[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[I][k]*R[k][j];
}
S[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
printf("PAGE RANK OF PAGE %d is
%f\n", i+1, S[i][j]);
}
}
break;
default: printf("INVALID INPUT");
break;
}
clock_t stop = clock();
double elapsed = (double)(stop - start) *
1000.0 / CLOCKS_PER_SEC;
printf("Time elapsed in ms: %f", elapsed);
return 0;
}
```

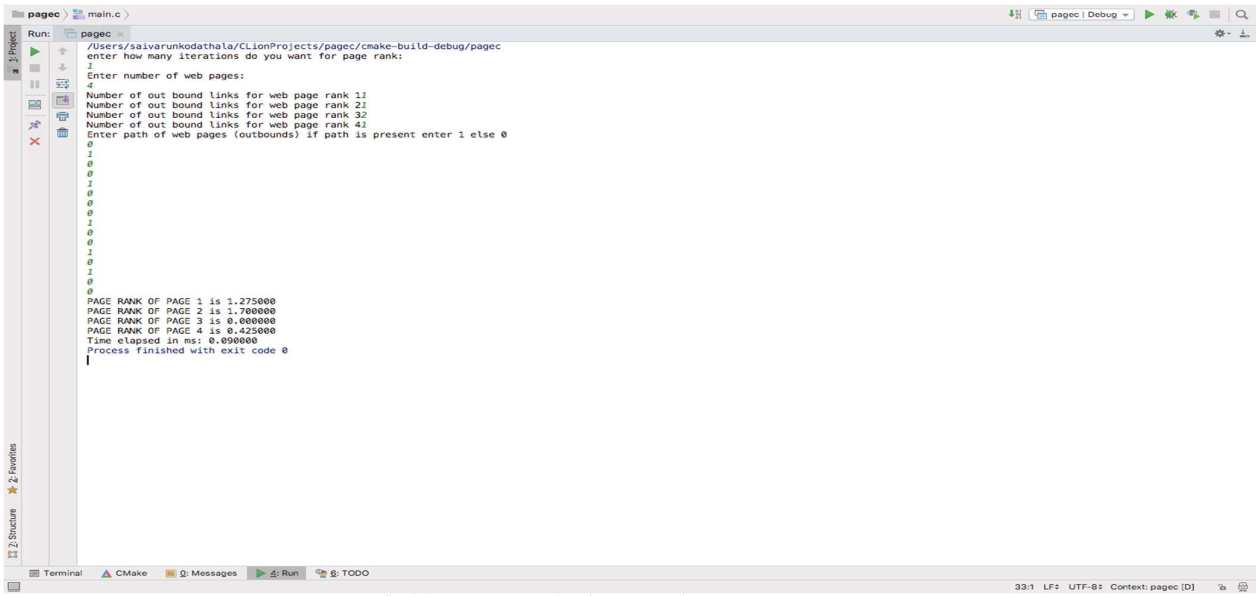



fig (5): Output Console of C executed program

Program in C++ - Language:

C++ is well known as extension of C language and was developed by Bjarne stroustrup, C++ is object oriented programming language whereas C is procedure oriented programming language it has some beneficial features like encapsulation, abstraction, inheritance, polymorphism, class binding and message passing [14]. The process is followed as same as the process of C language but in C++ it is easy to print and access the variables. The output is given in fig (6). The program is given below

```
#include<iostream>
#include<time.h>
using namespace std;
int main()
{
int iteration,page[50],n,i,j,k;
float
N[50][50],M[50][50],N1[50][50],V[50][50],Q[50][5
0],R[50][50],S[50][50],sum=0;
cout<<"enter how many iterations do you want for
page rank: \n";
cin>> iteration;
cout<< "Enter number of web pages: \n";
cin>> n;
for(i=0;i<n;i++)
{
cout<< "Number of out bound links for web page
rank " << i+1;
cin>>page[i];
}
cout<<"Enter path of web pages (outbounds) if path
is present enter 1 else 0\n";
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
cin>>M[i][j];
}
}
clock_t start = clock();
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
N[i][j]= M[i][j]/page[i];
}
}
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
N1[j][i] = N[i][j];
}
}
for(i=0;i<n;i++)
{
V[i][0]= 0.85;
}
switch (iteration)
{
case 1: for(i=0;i<n;i++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*V[k][0];
}
Q[i][0] = sum;
sum=0;
}
for(i=0;i<n;i++)
{
cout<< "PAGE RANK OF PAGE" << i+1 << "is"
<<Q[i][0]<<"\n";
}
break;
case 2: for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*V[k][j];
}
Q[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*Q[k][j];
}
R[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
cout<<"PAGE RANK OF PAGE" <<
i+1<<"is"<<R[i][j]<<"\n";
}
}
break;
case 3: for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*V[k][j];
}
Q[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*Q[k][j];
}
R[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
sum = sum + N1[i][k]*R[k][j];
}
S[i][j] = sum;
sum=0;
}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
cout<<"PAGE RANK OF PAGE"<<i+1<<"
is"<<S[i][j]<<"\n";
}
}
break;
default: cout<<"INVALID INPUT";
break;
}
clock_t stop = clock();
double elapsed = (double)(stop - start) * 1000.0 /
CLOCKS_PER_SEC;
cout<<"Time elapsed in ms: "<<elapsed;
return 0;
}
```

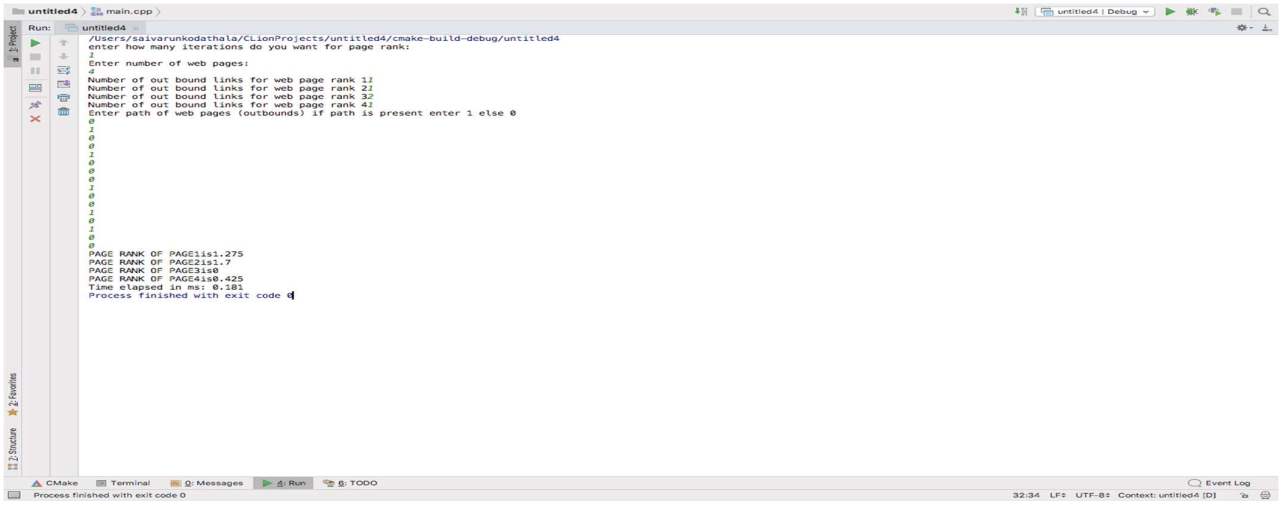



fig (6): Output console of C++ program execution.

Program in JAVA:

Java is high level language which was developed by James Goslings, Java is object oriented programming it works on the principle of write once and run anywhere (WORA). It was owned by Sun Micro Systems [15]. Java syntax are similar to C++. The program in java is given below. The output of program is given in fig (7).

```
import java.util.*;
class javarank
{
public static void main(String args[])
{
int iteration,n,i,j,k;
float[][] Q = new float[50][50];
float[][] R = new float[50][50];
float[][] S = new float[50][50];
System.out.println("enter how many iterations do
you want for page rank");
Scanner in= new Scanner(System.in);
iteration=in.nextInt();
System.out.println("enter number of web pages");
n=in.nextInt();
int page[]=new int[50];
for(i=0;i<n;i++)
{
System.out.print("Number of out bound links of
webpage ");
System.out.print(i+1);
page[i]=in.nextInt();
}
float[][] M=new float[50][50];
System.out.println("Enter path of web pages
(outbounds) if path is present enter 1 else 0");
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
M[i][j]=in.nextFloat();
}
}
long startTime = System.nanoTime();
float[][] N= new float[50][50];
float[][] N1=new float[50][50];
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
N[i][j]= M[i][j]/page[i];
}
}
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
{
N1[j][i] = N[i][j];
}
}
float[][] V= new float[50][50];
for(i=0;i<n;i++)
{
V[i][0]= 0.85f;
}
switch (iteration)
{
case 1:
for(i=0;i<n;i++)
{
for(k=0;k<n;k++)
{
Q[i][0]= Q[i][0] + N1[i][k]*V[k][0];
}

}

for(i=0;i<n;i++)
{
System.out.print("PAGE RANK OF PAGE ");
System.out.print(i+1);
System.out.print(" is");
System.out.println(Q[i][0]);
}
break;
case 2:
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
Q[i][j] = Q[i][j] + N1[i][k]*V[k][j];
}

}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
R[i][j] = R[i][j] + N1[i][k]*Q[k][j];
}

}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
System.out.print("PAGE RANK OF PAGE ");
System.out.print(i+1);
System.out.print(" is");
System.out.println(R[i][0]);
}
}
break;
case 3:
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
Q[i][j] = Q[i][j] + N1[i][k]*V[k][j];
}

}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
R[i][j] = R[i][j] + N1[i][k]*Q[k][j];
}

}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
for(k=0;k<n;k++)
{
S[i][j] = S[i][j] + N1[i][k]*R[k][j];
}

}
}
for(i=0;i<n;i++)
{
for(j=0;j<1;j++)
{
System.out.print("PAGE RANK OF PAGE ");
System.out.print(i+1);
System.out.print(" is");
System.out.println(S[i][0]);
}
}
break;
default: System.out.println("INVALID INPUT");
break;
}
long endTime   = System.nanoTime();
long totalTime = endTime - startTime;
System.out.println("EXECUTION TIME : IN SECS
:");
System.out.println(totalTime * 0.000000001);
}
}
```

```
programs — -bash — 144×43
Last login: Mon May 28 11:32:25 on ttys000
SAIs-Air:~ saivarunkodathala$ cd varun/programs
SAIs-Air:programs saivarunkodathala$ javac javarank.java
SAIs-Air:programs saivarunkodathala$ java javarank
enter how many iterations do you want for page rank
1
enter number of web pages
4
Number of out bound links of webpage 11
Number of out bound links of webpage 21
Number of out bound links of webpage 32
Number of out bound links of webpage 41
Enter path of web pages (outbounds) if path is present enter 1 else 0
0
1
0
0
1
0
0
0
1
0
0
1
0
1
0
0
PAGE RANK OF PAGE 1 is1.2750001
PAGE RANK OF PAGE 2 is1.7
PAGE RANK OF PAGE 3 is0.0
PAGE RANK OF PAGE 4 is0.425
EXECUTION TIME : IN SECS :
0.005173451
SAIs-Air:programs saivarunkodathala$
```

fig (7): Output console of Java program

Program in PYTHON :

Python is a high level language which was designed by Guido Van Rossum in 1991 and developed by Python Software foundation. Python converts its usability dynamically which reduces the size of code and complexity of understanding the program. It allows user to operate more

quickly and efficiently. Python supports Procedure oriented, Object oriented, Modular and Imperative programming language [16]. Python is used for signal processing and Artificial Intelligence [17]. The program in python is given below and the output is given in fig (8).

```
import numpy as np
M=[]
P=[]
N1=[]
N=[]
V=([])
S=R=Q=N1=[[0,0,0,0],
  [0,0,0,0],
  [0,0,0,0],
  [0,0,0,0]]
iteration =int(input("enter how many iterations do you want for
page rank"))
n=int(input("enter number of web pages"))
for i in range(0,n):
   print("enter the number of outbound links",i+1)
   P.append(float(input()))
print("enter the path details if path is present enter 1, else 0")
for i in range(0,n):
   M.append([float(input())])
   for j in range(1,n):
      M[i].append(float(input()))
from time import time
start_time = time()
for i in range(0,n):
   N.append([])
   for j in range(0,n):
      N[i].append(M[i][j]/P[i])
for i in range(len(N)):
   for j in range(len(N[0])):
      N1[j][i] = N[i][j]
for i in range(0,n):
   for j in range(0,1):
      V.append(0.85)
if(iteration == 1):
   Q = np.dot(N1,V)
   for i in range(0,n):
      for j in range(0,1):
         print("page rank of",i+1)
         print("is",Q[i])
elif(iteration == 2):
   Q = np.dot(N1,V)
   R = np.dot(N1,Q)
   for i in range(0,n):
      for j in range(0,1):
         print("page rank of",i+1)
         print("is",R[i])
elif(iteration ==3):
   Q = np.dot(N1,V)
   R = np.dot(N1,Q)
   S = np.dot(N1,R)
   for i in range(0,n):
      for j in range(0,1):
         print("page rank of",i+1)
         print("is",S[i])
end_time = time()
time_taken = end_time - start_time
print("execution time:",time_taken)
else:
   print("INVALID")
```

```
Python 3.7.0b4 (v3.7.0b4:eb96c37699, May  2 2018, 04:13:13)
[Clang 6.0 (clang-600.0.57)] on darwin
Type "copyright", "credits" or "license()" for more information.
>>>
 RESTART: /Users/saivarunkodathala/Documents/web page ranking/ashokpythonking.py
enter how many iterations do you want for page rank1
enter number of web pages4
enter the number of outbound links 1
1
enter the number of outbound links 2
1
enter the number of outbound links 3
2
enter the number of outbound links 4
1
enter the path details if path is present enter 1, else 0
0
1
0
0
1
0
0
0
1
0
0
1
0
1
0
0
page rank of 1
is 1.275
page rank of 2
is 1.7
page rank of 3
is 0.0
page rank of 4
is 0.425
execution time: 0.6036229133605957
>>>
```

fig (8): Output console of Python program

**Results:**

The Variation in time of execution is given in fig (9):

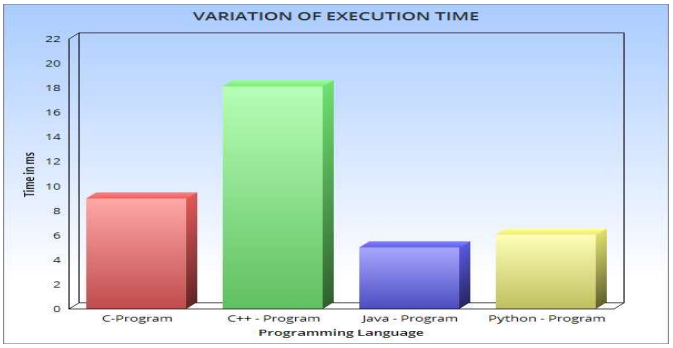



Fig (9): Bar graph which depicts the variation of execution time

The variation in size occupation by different languages is given in fig (10):

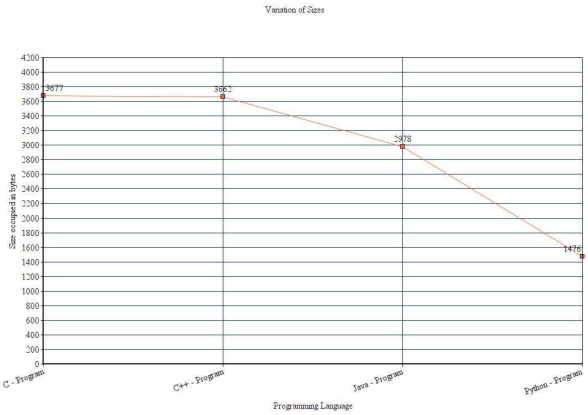
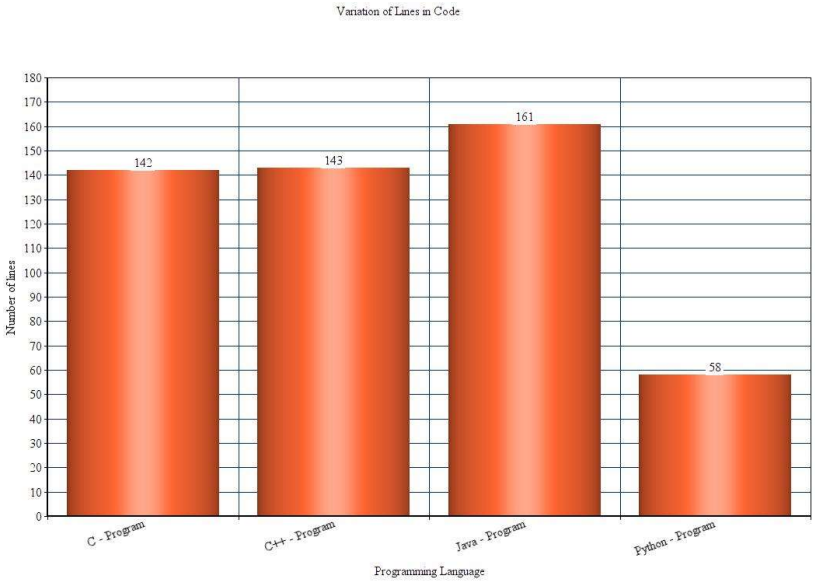



Fig (10): The line graph which depicts the size occupation by different programming languages

The variation in number of lines in code of each language is represented in fig (11):




fig(11) : The bar graph which depicts variation of lines in code

**Conclusions:**

In the present situations, time and complexity are two important factors to manage. Those two can be managed by adopting programing language instead of mathematical approach because programming language uses mathematics to compute the result but don't insist the users to know about the concept. Anyone can utilize this from anywhere moreover the result obtained is very accurate, precise and time conscious it doesn't take much time to compute the result which is favor to all users. Among these four (C, C++, JAVA, PYTHON) programming languages python is more prominent and easy to work on it. It's important to choose Python language to compute web page ranking instead of opting other languages which require large code, conditions and more complex.

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