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TOTAL DOMINATOR CHROMATIC NUMBER OF PATHS AND CYCLES THROUGH COMPUTER PROGRAMMING

Mathematics

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ABSTRACT

A total dominator coloring of a graph G=(V,E) without isolated vertices is a proper coloring together with each vertex in G properly dominates a color class. The total dominator chromatic number of G is a minimum number of color classes with additional condition that each vertex in G properly domi- nates a color class and is denoted by $\chi_{td}(G)$. In this paper we introduce C++ programmes that are able to efficiently determine on approximation to the total dominator chromatic number of Paths and Cycles.
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KEYWORDS

Total dominator coloring, Total dominator chromatic number.

INTRODUCTION

In this paper we only consider Paths and Cycles. Further details in graph theory can be found in F.Harrary[4]

Let G=(V,E) be a graph with minimum degree atleast one. The Path and Cycle of order n are denoted by P_n and C_n respectively.

A proper coloring of G is an assignment of colors to the vertices of G, such that adjacent vertices have different colors. The smallest number of colors for which there exists a proper coloring of G is called a chromatic number of G, and is denoted by $\chi(G)$. A total dominator coloring (td-coloring) of G is a proper coloring of G with extra property that every vertex in G properly dominates color class. The total dominator chromatic number is denoted by $\chi_{td}(G)$ and is defined by the minimum number of colors needed in a total dominator coloring of G. This concept was introduced by A.Vijayalekshmi in [1]. This notion is also referred as a smarandachely k-dominator coloring of G,(k ≥ 1) and was introduced by A.Vijayalekshmi in [2].For an integer k ≥ 1, a smarandachely k-dominator coloring of G is a proper coloring of G, such that every vertex in a graph G properly dominates a k color class. The smallest number of colors for which there exists a smarandachely k-dominator coloring of G is called the smarandachely k-dominator chromatic number of G and is denoted by $\chi^{s}_{td}(G)$.

In a proper coloring C of a graph G, a color class of C is a set consisting of all those vertices assigned the same color. Let C be a minimum td-coloring of G. We say that a color class is called a non-dominated color class (n-d color class)if it is not dominated by any vertex of G and these color classes are also called repeated color classes.

The total dominator chromatic number of Paths and Cycles were found in [3]. We have the following observation from [3]

Theorem A [3]
Let G be P_n or C_n. Then

$$\chi_{td}(P_n) = \chi_{td}(C_n) = \begin{cases} 2\left\lfloor\frac{n}{4}\right\rfloor + 2 \; if \; n \equiv 0(mod4) \\ 2\left\lfloor\frac{n}{4}\right\rfloor + 3 \; if \; n \equiv 1(mod4) \\ 2\left\lceil\frac{n+2}{4}\right\rceil + 2 \; Otherwise \end{cases}$$

Main Results
Section 1.1
In this section we have to find the total dominator chromatic number of paths by using C++ programme.

A path of 'n' vertices, denoted by P_n, is a connected graph where all but two vertices have degree 1. We label the vertices of P_n as v_i for $(1 \le i \le n)$. Furthermore let (v_i, v_{i+1}) be an edge of P_n for $i<n$.

Here is the source code of C++ programme to find the total dominator chro- matic number of Paths. The C++ programme is successfully compiled and run on C++ platform.

Program as follows

```
#include "stdafx.h"
#include <Windows.h>
#include <conio.h>

#include <iostream> using namespace std; int main() {
int inpt;

cout << "Enter the Value" << endl;
cin >> inpt;
while (inpt >= 11)

{
int n = inpt; // matrix row
int m = inpt; // matrix column
// dynamic allocation

int** ary = new int*[n]; //logic matrix int** mat = new int*[n]; //adjacency matrix for (int i = 0; i < n; ++i)

{
ary[i] = new int[m];
mat[i] = new int[m];
}

// fill ary

for (int i = 0; i < n; ++I) for (int j = 0; j < m; ++j) ary[i][j] = i; system("pause"); system("cls");
cout << "\n";

cout << "The Adjacency Matrix for P" << n << "\n" << "\n";
for (int i = 0; i < n; I++)
{
for (int j = 0; j < n; j++)
{
if (ary[j][i] == i + 1 | ary[j][i] == i - 1)
{
mat[i][j] = 1;
cout << mat[i][j] << " ";
}

else
{
mat[i][j] = 0;
cout << mat[i][j] << " ";
}
}
cout << "\n";
}
```

```
system("pause");
// -----END LOGIC TO FORM MATRIX------ int d;
cout << "\n";

if (n % 4 == 3)// CONDITION FOR GETTING SUB MATRIX
{
cout << "Order of sub matrices for the above Matrix is : " << (2 * (n / 4))
<< "x" << (2 * (n / 4)) << "\n";

d = 2 * (n / 4);
cout << "\n";
}

else // CONDITION FOR GETTING SUB MATRIX

{
cout << "Order of sub matrices for the above Matrix is : " << (2 * (n / 4)
- 1)
<< "x" << (2 * (n / 4) - 1) << "\n";
d = 2 * (n / 4) - 1;
cout << "\n";
}

cout << "for sub matrices" << " ";
system("pause");
system("cls");
cout << "Sub Matrices" << " " << d << "x" << d;
cout << "\n" << "\n";
int r = 0;// matrix row
int c = 0;// matrix column int k;
int l;
if (n % 4 == 0)

{
l = n / 2 + 2;
}

else

{
l = n / 2 + 3;
}

HANDLE hConsole = GetStdHandle(STD_OUTPUT_HANDLE);
for (k = 0; k < l; k++)

{
cout << "Sub Matrix" << " " << k + 1;
cout << "\n" << "\n";
for (int i = 0; i < n; I++)
{
for (int j = 0; j < n; j++)
{
if (j >= k && j < d && i >= k && i < d)
{
SetConsoleTextAttribute(hConsole, FOREGROUND_RED | FOREGROUND_INTENSITY);
cout << mat[i][j] << " ";
}

else

{
SetConsoleTextAttribute(hConsole, FOREGROUND_GREEN | FOREGROUND_INTENSITY);
//cout << "." << " ";
cout << mat[i][j] << " ";
}
}
cout << "\n";
}

if (k == l - 1)

{
SetConsoleTextAttribute(hConsole, FOREGROUND_GREEN | FOREGROUND_INTENSITY);
cout << "\n";
cout << " No. of Sub Matrices are" << " " << l;
cout << "\n";
cout << "\n";
cout << " Total Dominator Chromatic Number of " << "P" << n << " "
<< "is"
<< " " << l;
cout << "\n";
cout << "\n";
} system("pause"); system("cls"); d++;
}
return 0;
for (int i = 0; i < n; ++I)
delete[] ary[i]; delete[] ary; return 0;
}
return main();
}
```

Runtime Test

```
Enter the Value
13
Press any key to continue . . .
```

```
The Adjacency Matrix for P13

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Order of sub matrices for the above Matrix is : 5x5
for sub matrices Press any key to continue . . .
```

```
Sub Matrices 5x5

Sub Matrix 1

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 2

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 3

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 4

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 5

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 6

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 7

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 8

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 9

0 1 0 0 0 0 0 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 1 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0

 No. of Sub Matrices are 9

 Total Dominator Chromatic Number of P13 is 9
Press any key to continue . . .
```

Section 1.2

Program source code

In this section, we give the source code of the C++ program to find the td- chromatic number of a cycle. A cycle on n vertices denoted by C_n is a connected graph where each vertex has degree two. We label the vertices of c_n as v_i for $1 \leq i \leq n$ and let (v_i, v_{i+1}) be an edge of C_n for $1 \leq i \leq n - 1$. We let (v_n, v_1) be the remaining edge of C_n. The program is successfully compiled and tested under C++ platform. The program output is also shown below

Program as follows

```
#include "stdafx.h"
#include <Windows.h>
#include <conio.h>F

#include <iostream> using namespace std; int main() {
int inpt;

cout << "Enter the Value" << endl;
cin >> inpt;
while (inpt >= 11)

{
// dimensions
int n = inpt; // matrix row
int m = inpt; // matrix column
// dynamic allocation
int** ary = new int*[n]; //logic matrix

int** mat = new int*[n]; //adjacency matrix for (int i = 0; i < n; ++i)
{
ary[i] = new int[m];
mat[i] = new int[m];
}

// fill ary

for (int i = 0; i < n; ++I) for (int j = 0; j < m; ++j) ary[i][j] = i;
system("pause"); system("cls");
cout << "\n";
cout << "The Adjacency Matrix for C" << n << "\n" << "\n";
// -----LOGIC TO FORM MATRIX------ for (int i = 0; i < n; I++)
{

for (int j = 0; j < n; j++)

{
if (ary[j][i] == i + 1 | ary[j][i] == i - 1 | ary[j][i] == i + (n - 1)
| ary[j][i] == i - (n - 1))
{
mat[i][j] = 1;
cout << mat[i][j] << " ";
}

else

{
mat[i][j] = 0;
cout << mat[i][j] << " ";
}
}
```

```
cout << "\n";
}

system("pause");
// -----END LOGIC TO FORM MATRIX------ int d;
cout << "\n";

if (n % 4 == 3)// CONDITION FOR GETTING SUB MATRIX

{

cout << "Order of sub matrices for the above Matrix is : " << (2 * (n / 4))
<< "x" << (2 * (n / 4)) << "\n";
d = 2 * (n / 4);
cout << "\n";
}

else // CONDITION FOR GETTING SUB MATRIX

{
cout << "Order of sub matrices for the above Matrix is : " << (2 * (n / 4)
- 1)
<< "x" << (2 * (n / 4) - 1) << "\n";
d = 2 * (n / 4) - 1;
cout << "\n";
}

cout << "for sub matrices" << " ";
system("pause");
system("cls");
cout << "Sub Matrices" << " " << d << "x" << d;
cout << "\n" << "\n";

int r = 0;// matrix row
int c = 0;// matrix column int k;
int l;
// final value--------------- if (n % 4 == 0)
{
l = n / 2 + 2;
}

else

{
l = n / 2 + 3;
}

HANDLE hConsole = GetStdHandle(STD_OUTPUT_HANDLE);
for (k = 0; k<l; k++)

{
cout << "Sub Matrix" << " " << k + 1;
cout << "\n" << "\n";
for (int i = 0; i < n; I++)
{
for (int j = 0; j < n; j++)
{
if (j >= k && j<d && i >= k && i <d)
{
SetConsoleTextAttribute(hConsole, FOREGROUND_RED | FOREGROUND_INTENSITY);
cout << mat[i][j] << " ";
}

else
{
SetConsoleTextAttribute(hConsole, FOREGROUND_GREEN | FOREGROUND_INTENSITY);
//cout << "." << " ";
cout << mat[i][j] << " ";
}
}
cout << "\n";
}
if (k == l - 1)
{
SetConsoleTextAttribute(hConsole, FOREGROUND_GREEN | FOREGROUND_INTENSITY);
cout << "\n";
cout << " No. of Sub Matrices are" << " " << l;
cout << "\n";
cout << "\n";
cout << " Total Dominator Chromatic Number of " << "C" << n << " "
<< "is"
<< " " << l;
cout << "\n";
cout << "\n";
} system("pause"); system("cls"); d++;
}
return 0;
}
return main();
}
```

Runtime Test

```
Sub Matrix 3

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 4

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 5

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . . _
```

```
Sub Matrix 6

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . . _
```

```
Sub Matrix 7

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . . _
```

```
Sub Matrix 8

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 9

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . . _
```

```
Sub Matrix 10

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 11

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
Press any key to continue . . .
```

```
Sub Matrix 12

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0

 No. of Sub Matrices are 12

 Total Dominator Chromatic Number of C20 is 12

Press any key to continue . . . _
```

CONCLUSION

In this paper, we investigated the hard counting problems, the total domi- nator chromatic number of paths and cycles. By introducing and equivalent rare-event estimation problem. We were able to apply the evolutionary C++ approach. We showed the C++ program provides a provable probabilistic performance lower bound guarantee which is easy to calculate on line. Our numerical output indicate that the proposed method is successful.

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