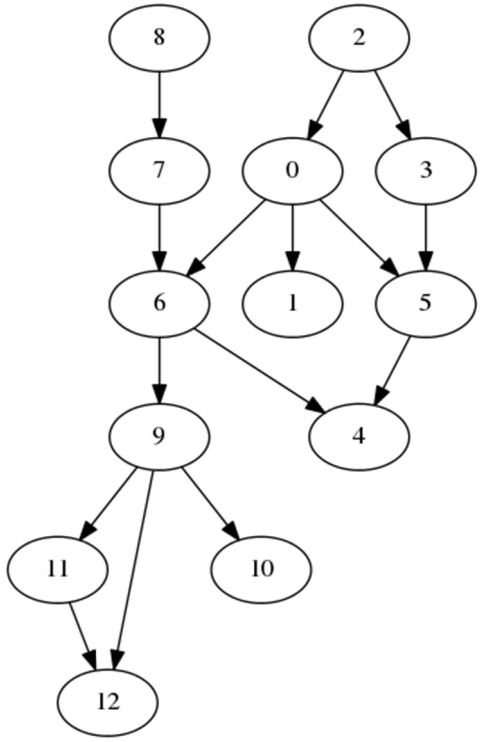
Computational Lab - Assignment 3: Directed Acyclic Graph (DAG) with DOT visualization
By: Pankaj Azad, Roll Number - 14M517, M.Tech Ist Sem

Enter number of vertices...13
Enter the edges (E.g. 4 3 means a directed edge from 4 to 3). -1 -1 as input stops the process
0 5
0 1
0 6
2 0
2 3
3 5
5 4
6 4
6 9
7 6
8 7
9 11
9 12
9 10
11 12
-1 -1

Enter any of the following available choices
1 - Add Edge(s)
2 - Delete Edge(s)
3 - Print Adjacency list and draw graph (generates a png image)
4 - Depth First Search (DFS)
5 - Detect existence of cycle
9 - Exit
3
DAG: 13 Vertices and 15 Edges
[0] => 5 1 6
[1] =>
[2] => 0 3
[3] => 5
[4] =>
[5] => 4
[6] => 4 9
[7] => 6
[8] => 7
[9] => 11 12 10
[10] =>
[11] => 12
[12] =>



Enter any of the following available choices
1 - Add Edge(s)
2 - Delete Edge(s)
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4
Enter the source node for DFS...2
DFS from 2 : 2, 0, 5, 4, 1, 6, 9, 11, 12, 10, 3,

Enter any of the following available choices
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9 - Exit
5

No Cycle found!!

Enter any of the following available choices
1 - Add Edge(s)
2 - Delete Edge(s)
3 - Print Adjacency list and draw graph (generates a png image)
4 - Depth First Search (DFS)
5 - Detect existence of cycle
9 - Exit
1
Enter the edges (E.g. 4 3 means a directed edge from 4 to 3). -1 -1 as input stops the process
12 0
-1 -1

Enter any of the following available choices
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5
Edge 12,0 is involved in cycle
Cycle Exits!!

Enter any of the following available choices
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3 - Print Adjacency list and draw graph (generates a png image)
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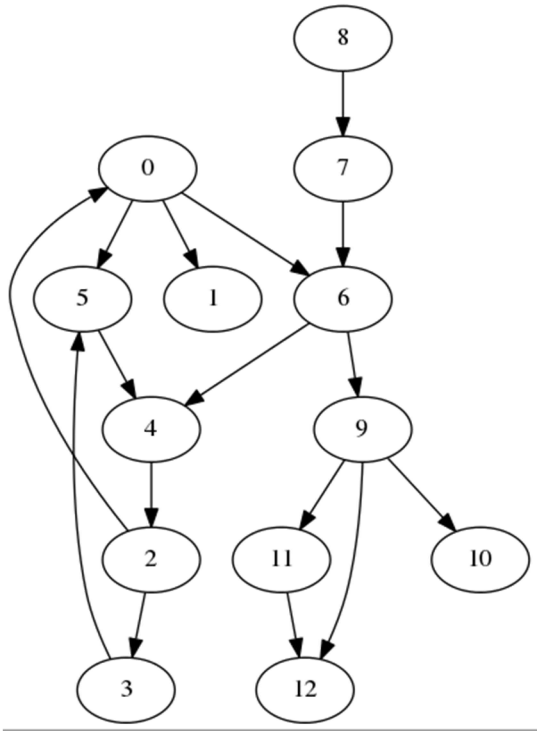
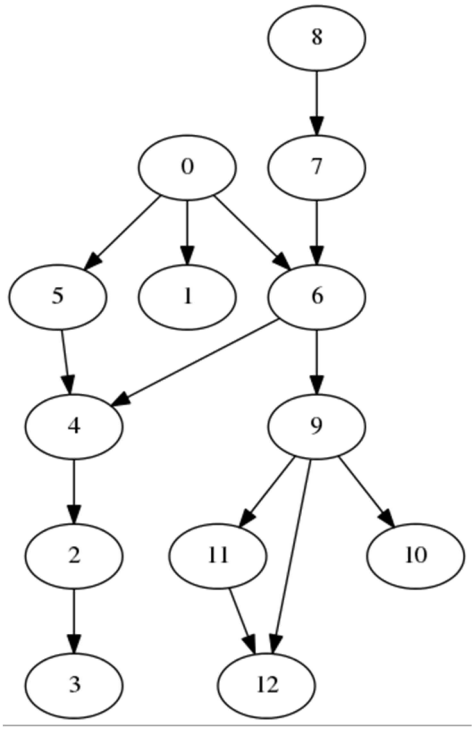
5 - Detect existence of cycle
9 - Exit
3
DAG: 13 Vertices and 16 Edges
[0] => 5 1 6
[1] =>
[2] => 0 3
[3] => 5
[4] =>



[5] => 4
[6] => 4 9
[7] => 6
[8] => 7
[9] => 11 12 10
[10] =>
[11] => 12
[12] => 0

Enter any of the following available choices
1 - Add Edge(s)
2 - Delete Edge(s)
3 - Print Adjacency list and draw graph (generates a png image)
4 - Depth First Search (DFS)
5 - Detect existence of cycle
9 - Exit
2
Enter the edges (E.g. 4 3 means a directed edge from 4 to 3). -1 -1 as input stops the process
0 6
-1 -1

Enter any of the following available choices
1 - Add Edge(s)
2 - Delete Edge(s)
3 - Print Adjacency list and draw graph (generates a png image)
4 - Depth First Search (DFS)
5 - Detect existence of cycle
9 - Exit
3
DAG: 13 Vertices and 15 Edges
[0] => 5 1
[1] =>
[2] => 0 3
[3] => 5
[4] =>
[5] => 4
[6] => 4 9
[7] => 6
[8] => 7
[9] => 11 12 10
[10] =>
[11] => 12
[12] => 0



Enter any of the following available choices
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4 - Depth First Search (DFS)
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9 - Exit
9

SOURCE CODE

dag.h

```
#include <iostream>
#include <list>
#include <vector>
using namespace std;

enum Color { WHITE, GREY, BLACK };

class Dag
{
    public:
        Dag(int vertices);
        ~Dag();

        int vertices() { return numberOfVertices; }
        int edges() { return numberOfEdges; }

        bool addEdge(int src, int dst);
        void addEdges();

        bool deleteEdge(int src, int dst);
        void deleteEdges();

        vector<int>& performDfsFromGivenSource();
        void dfs(int sourceVertex);

        bool doesCycleExist();
        bool visit(int vertex);

        friend ostream &operator << (ostream &out, const Dag &dag);

    private:
        int numberOfEdges;
        int numberOfVertices;
        list<int>* adjList;
        char* colorList;
        vector<int> dfsOutputList;
};
```

Dag.cpp

```
#include "dag.h"
#include <fstream>
#include <cstdlib>
#include <string>
#include <sstream>

using namespace std;

Dag::Dag(int vertices)
{
    numberOfVertices = vertices;
    numberOfEdges    = 0;

    adjList = new list<int>[numberOfVertices];
    colorList = new char[numberOfVertices];
}

Dag::~Dag()
{
```

```
    delete adjList;
    delete colorList;
}

bool Dag::addEdge(int src, int dst)
{
    bool ret = false;
    if( src < numberOfVertices && dst < numberOfVertices)
        {
        adjList[src].push_back(dst);
        numberOfEdges++;
        ret = true;
        }
    return ret;
}

bool Dag::deleteEdge(int src, int dst)
{
    bool ret = false;
    if( src < numberOfVertices && dst < numberOfVertices)
        {
        adjList[src].remove(dst);
        numberOfEdges--;
        ret = true;
        }
    return ret;
}

ostream &operator << (ostream &out, const Dag &dag)
{
    static int dotfileNumber=0;
    dotfileNumber++;

    out << "DAG: " << dag.numberOfVertices << " Vertices and " << dag.numberOfEdges << " Edges "
<< endl;

    ofstream dotfile;
    ostringstream dotfileName;
    dotfileName <<"dag" << dotfileNumber << ".dot";
    dotfile.open(dotfileName.str().c_str(),ofstream::out);
    dotfile << "digraph G {" << endl;

    for (int index = 0; index < dag.numberOfVertices; index++)
        {
        out << "["<< index << "] => " ;
        for (list<int>::iterator it=dag.adjList[index].begin(); it != dag.adjList[index].end();
++it)
            {
                out << *it << " " ;
                dotfile << "\t "<< index << " -> " << *it << ";" << endl;
            }
        cout << endl;
        }
    dotfile << "}" << endl;
    dotfile.close();

    ostringstream dagGenerationCommand;
    dagGenerationCommand << "dot -Tpng dag" << dotfileNumber << ".dot -o dag" << dotfileNumber <<
".png";
    system(dagGenerationCommand.str().c_str());
```

```
    ostringstream imageOpeningCommand;
    imageOpeningCommand << "ristretto dag" << dotfileNumber << ".png" << "&";
    system(imageOpeningCommand.str().c_str());
    return out;
}

void Dag::addEdges()
{

    int src, dst;
    cout << "Enter the edges (E.g. 4 3 means a directed edge from 4 to 3). -1 -1 as input stops
the process" << endl;
    do
        {
            cin >> src >> dst;

            if(src!=-1 && !addEdge(src,dst))
                cout <<"Failed to add this edge, (Try again with vertex numbers between range
(0,TotalVertices -1))"  << endl;

        }while(src!=-1);
}


void Dag::deleteEdges()
{

    int src, dst;
    cout << "Enter the edges (E.g. 4 3 means a directed edge from 4 to 3). -1 -1 as input stops
the process" << endl;
    do
        {
            cin >> src >> dst;

            if(src!=-1 && !deleteEdge(src,dst))
                cout <<"Failed to add this edge, (Try again with vertex numbers between range
(0,TotalVertices -1))"  << endl;

        }while(src!=-1);
}

vector<int>& Dag::performDfsFromGivenSource()
{
    int src;
    cout << "Enter the source node for DFS...";
    cin >> src;

    dfsOutputList.clear();
    for(int i=0;i<numberOfVertices;i++)
    {
        colorList[i] = WHITE;
    }
    dfs(src);
    cout << "DFS from " << src << " : ";

    for(int i=0;i<dfsOutputList.size();i++)
        cout << dfsOutputList[i] << ", ";

    cout << endl;
    return dfsOutputList;
}
```

```
void Dag::dfs(int sourceVertex)
{
    colorList[sourceVertex] = BLACK;
    dfsOutputList.push_back(sourceVertex);

    for(list<int>::iterator it = adjList[sourceVertex].begin(); it != adjList[sourceVertex].end();
++it)
        {
            if ( colorList[*it] != BLACK )
                dfs(*it);
        }
}

bool Dag::doesCycleExist()
{
    for(int i=0;i<numberOfVertices;i++)
    {
        colorList[i] = WHITE;
    }

    for(int i=0;i<numberOfVertices;i++)
    {
        if( colorList[i] == WHITE )
            {
                if ( visit(i) )
                    return true;
            }
    }
    return false;
}

bool Dag::visit(int v)
{
    int u;
    colorList[v] = GREY;

    for (list<int>::iterator it = adjList[v].begin(); it != adjList[v].end(); ++it)
        {
            u = *it;

            if ( colorList[u] == GREY)
                {
                cout << "Edge " << v << "," << u << " is involved in cycle" << endl;
                return true;
                }
            else if (colorList[u] == WHITE)
                {
                    if ( visit(u) )
                        return true;
                }
        }

    colorList[v] = BLACK;
    return false;
}
```

main.cpp

```
#include <iostream>
#include <cstdlib>
#include <cstdio>
```

```cpp
#include "dag.h"

#ifdef __linux__
    #define CLEAR_SCREEN system("clear")
#elif _WIN32
    #define CLEAR_SCREEN system("cls")
#endif

using namespace std;

int main()
{
    int input=0,vertices=0;

    CLEAR_SCREEN;

    cout << "\nComputational Lab - Assignment 3: Directed Acyclic Graph (DAG) with DOT
visualization";
    cout << "\nBy: Pankaj Azad, Roll Number - 14M517, M.Tech Ist Sem\n\n\n" << endl;

    cout << "Enter number of vertices...";
    cin >> vertices;

    Dag dag(vertices);


    dag.addEdges();

    do
    {
        cout << "\n\n\n";
        cout << "Enter any of the following available choices" << endl;
        cout << "1 - Add Edge(s)" << endl;
        cout << "2 - Delete Edge(s)" << endl;
        cout << "3 - Print Adjacency list and draw graph (generates a png image)" << endl;
        cout << "4 - Depth First Search (DFS)" << endl;
        cout << "5 - Detect existence of cycle" << endl;
        cout << "9 - Exit" << endl;

        cin >> input;
        switch(input)
        {
            case 1:
                dag.addEdges();
                break;

            case 2:
                dag.deleteEdges();
                break;

            case 3:
                cout << dag << endl;
                break;

            case 4:
                dag.performDfsFromGivenSource();
                break;

            case 5: cout << ( dag.doesCycleExist()? "\nCycle Exits!!\n": "\nNo Cycle found!!\n")
<< endl;
                break;
```

```
            case 9: exit(0);
                break;
        }

    }while(input!=9);

    return 0;
}
```