# CS 2123-001 Data Structures

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Homework 6  
**Due date: check BB Learn**  
!!!! NO LATE HOMEWORK WILL BE ACCEPTED !!!

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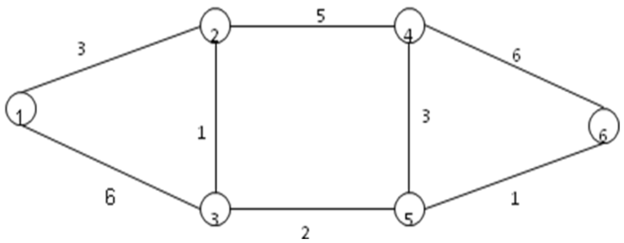
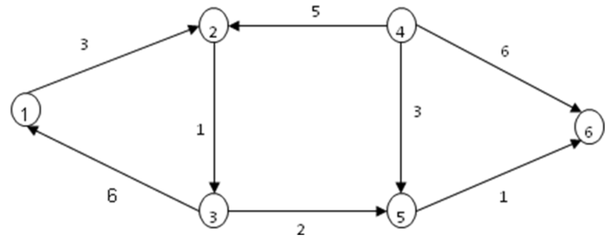
**(Graphs – graph functions)**

You are given the basic code that we implemented in the slides to create/read/print graphs. First copy/paste it into a file say **`graph.c`** and compile/run it.

- ➢ **`gcc graph.c -o graph`**
- ➢ **`graph graph_filename`**

For sample graphs, again copy/paste the below graph data into a file **`undirectedgraph1.txt`** and **`directedgraph1.txt`** then run your program as

- ➢ **`graph undirectedgraph1.txt`**
- ➢ **`graph directedgraph1.txt`**

| | |
|---|---|
|  1<br>2<br>3<br>4<br>5<br>6<br>3<br>5<br>6<br>1<br>3<br>6<br>2<br>1 |  1<br>2<br>3<br>4<br>5<br>6<br>3<br>5<br>6<br>1<br>3<br>6<br>2<br>1 |
| **undirectedgraph1.txt**<br>6 8 0<br>1 2 3<br>1 3 6<br>2 3 1<br>2 4 5<br>3 5 2<br>4 5 3<br>4 6 6<br>5 6 1 | **directedgraph1.txt**<br>6 8 1<br>1 2 3<br>2 3 1<br>3 1 6<br>3 5 2<br>4 2 5<br>4 5 3<br>4 6 6<br>5 6 1 |

After studying and understanding the given code, **first modify** `insert_edge()` function so that it can keep the link list sorted w.r.t. neighbor IDs. **Second implement** `graph_copy()` to create a copy of the given graph. User will call the original graph as **`myg1`** and the copy as **`myg2,`** for which we use the same pointer names in the program. Now extend **the main function** so that it can asks user to enter various commands in a loop and performs these commands on the related graphs. Accordingly you also need to **implement those functions** and call them. Finally when ending the main function, make sure you **free the graphs**…

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Specifically, your program will ask user to enter a command and related parameters (if any) in a loop, and then perform the given commands.   Here is the list of commands that your program must implement: [Your command names should be as written below so the TA can copy paste his/her test cases...]

```
*  insert           [myg1 | myg2] x y w
*  delete           [myg1 | myg2] x y

*  printgraph       [myg1 | myg2]
*  printdegree      [myg1 | myg2]   // if directed, print both in- and out-degree
*  printcomplement  [myg1 | myg2]

*  eliminatelinks   [myg1 | myg2]  minW maxW
*  differentlinks   [myg1 | myg2]  [myg1 | myg2]
*  commonlinks      [myg1 | myg2]  [myg1 | myg2]

*  dfs_print        [myg1 | myg2]  x
*  bfs_print        [myg1 | myg2]  x
*  isconnected      [myg1 | myg2]
*  numofconncomp    [myg1 | myg2]

*  quit
```

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As always, make sure you release (free) the dynamically allocated memories if you allocate any memory in your programs. So, before submitting your program, run it with `valgrind` to see if there is any memory leakage…

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Also if you need to debug your program, compile your programs with –g option and then run it with `gdb` and/or `ddd`.

/* Don't forget to include comments about the problem, yourself and each major step in your program!   */

As before implement your code, run it and save results in a text file under a directory. Then zip it and submit the whole directory as in previous assignments

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You must submit your work using Blackboard Learn and respect the following rules:

1) All assignments must be submitted as either a zip or tar archive file unless it is a single pdf file.
2) Assignments must include all source code.
3) Assignments must include an output.txt file which demonstrates the final test output run by the student.
4) If your assignment does not run/compile, the output.txt file should include an explanation of what was accomplished, what the error message was that prevented the student from finishing the assignment and what the student BELIEVES to be the underlying cause of the error.

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## graph.c

```
#include <stdio.h>
#include <stdlib.h>
typedef enum {FALSE, TRUE} bool;
#define MAXV 100

typedef struct edgenode {
   int y;
   int weight;
   struct edgenode *next;
} edgenodeT;

typedef struct {
   edgenodeT *edges[MAXV+1];
   int degree[MAXV+1];
   int nvertices;
   int nedges;  // number of directed edges....
   bool directed;
} graphT;
void initialize_graph(graphT *g, bool directed);
void read_graph(graphT *g, char *filename);
void insert_edge(graphT *g, int x, int y, int w);
void print_graph(graphT *g, char *name);
void free_graph(graphT *g);
graphT *copy_graph(graphT *g);
// put prototypes for other functions here....

int main(int argc, char *argv[])
{
  graphT   *myg1=NULL, *myg2=NULL;

  if(argc < 2){
    fprintf(stderr, "Usage: %s graph_filename", argv[0]);
    exit(-1);
  }
  myg1 = (graphT *) malloc(sizeof(graphT));
  if (myg1==NULL) {
    fprintf(stderr, "Cannot allocate memory for the graph");
    exit(-1);
  }
  initialize_graph(myg1, FALSE);
  read_graph(myg1, argv[1]);
  print_graph(myg1, "myg1");

  // first implement copy_graph function and call it here
  myg2 = copy_graph(myg1);
  print_graph(myg2, "myg2");

  // NOW in a loop get commands and
  // call related functions to perform them...
  free_graph(myg1);
}
```

```
void initialize_graph(graphT *g, bool directed)
{
   int i;
   g->nvertices = 0;
   g->nedges = 0;
   g->directed = directed;

   for (i=1; i<=MAXV; i++)
      g->edges[i] = NULL;

   for (i=1; i<=MAXV; i++)
      g->degree[i] = 0;
}

void read_graph(graphT *g, char *filename)
{
   int i;
   int n, m, dir;
   int x, y, w;
   FILE *fp;
   if((fp=fopen(filename,"r"))==NULL){
     fprintf(stderr, "Cannot open the graph file");
     exit(-1);
   }
   fscanf(fp,”%d %d %d”, &n, &m, &dir);
   g->nvertices = n;
   g->nedges  = 0; // insert function will increase it;
   g->directed  = dir;
   for (i=1; i<=m; i++) {
      fscanf(fp,”%d %d %d”, &x, &y, &w);
      insert_edge(g, x, y, w);
      if(dir==FALSE)
          insert_edge(g, y, x, w);
   }
   fclose(fp);
}
void insert_edge(graphT *g, int x, int y, int w)
{
   edgenodeT *pe;
   pe = malloc(sizeof(edgenodeT)); // check if NULL
   pe->weight = w;
   pe->y = y;

   // YOU MUST MODIFY THIS FUNCTION SO IT WILL KEEP LINK LIST SORTED
   // W.R.T. NEIGHBOR IDs.

   pe->next = g->edges[x];
   g->edges[x] = pe;

   g->degree[x]++;
   g->nedges++;
}
```

```
void print_graph(graphT *g, char *name)
{
   edgenodeT *pe;
   int i;
   if(!g) return;
   printf("Graph Name: %s\n", name);
   for(i=1; i<=g->nvertices; i++) {
      printf("Node %d: ", i);
      pe = g->edges[i];
      while(pe){
           //          printf(" %d", pe->y);
           printf(" %d(w=%d),", pe->y, pe->weight);
           pe = pe->next;
      }
      printf("\n");
   }
}

void free_graph(graphT *g)
{
   edgenodeT *pe, *olde;
   int i;
   for(i=1; i<=g->nvertices; i++) {
      pe = g->edges[i];
      while(pe){
          olde = pe;
          pe = pe->next;
          free(olde);
      }
   }
   free(g);
}

graphT *copy_graph(graphT *g)
{
  graphT *newg;

  // I simply return the same graph as a copy
  // but you really need to dynamically create
  // another copy of the given graph
  newg = g;

  return newg;

}

// your other functions
```

here are some clarifications

*  insert           myg1 3 4  20
insert a new edge 3-4 into myg1 graph with weight of 20. If this is an undirected graph also insert edge 4-3 with weight 20. If that edge is already in the graph, don't insert anything...

*  delete           myg1 2 4
delete edge 2-4 from myg1. If this is an undirected graph also delete edge 4-2. If that edge is not in the graph, don't delete anything...

*  printgraph       myg1
print graph using the code given...

*  printdegree      myg1
if myg1 is undirected, then simply count the number of neighbors in the adjacency list for each node and print that number as the degree of each node..

if the graph is directed, then again you can simply count the number of neighbors in the adjacency list for each node and print that number as the out-degree of each node... BUT you also need to find in-degree. For this, you can check every node (say node i)and count how many times node i appears in the all adjacency lists, and print that count as the in-degree for node i.

*  printcomplement  myg2
First create the complement graph of myg2 as cg, and call printgraph(cg) then free complement graph cg.

*  eliminatelinks   myg1 minW maxW

```
    check each edge  pe
    if (pe->w < minW || pe->w > maxW)  delete that edge
```

*  differentlinks   myg1 myg2

```
    print edges that are in myg1 but not in myg2
```

*  commonlinks      myg1  myg2
print edges that are both in myg1 and in myg2

*  dfs_print        myg1 x
print in which order nodes are visited
then for each node print the path from x to that node

*  bfs_print        myg2  x

print in which order nodes are visited
then for each node print the path from x to that node

```
*  isconnected      myg1
*  numofconncomp    myg2
```

last two comments isconnected numofconncomp will be performed
if the graph is UNdirected ...
if the graph is directed don't do anything or just print
"Purchase the next version of this program :)"