CSE344
FINAL
REPORT

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Summary: Project lacks a few things:

- Server is not a Daemon
- Writers are not prioritized

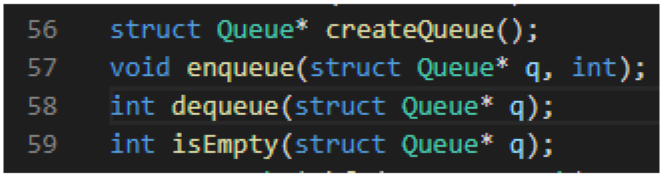
Rest of the project works well.

STRUCTURES

I implemented a Queue, Graph and a Cache data structure and their element structures for this project.

Queue

Queue is basic linked list based implementation. There are 4 supported methods and it is used during BFS



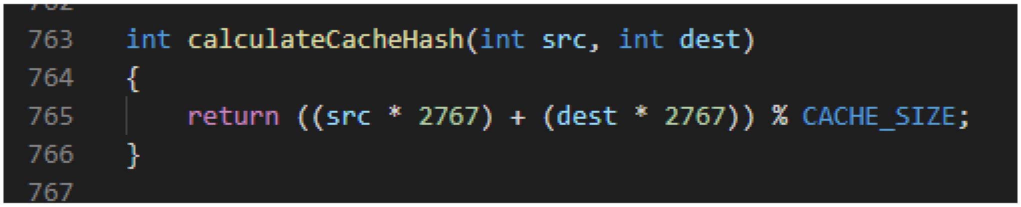
```
struct Queue* createQueue();
void enqueue(struct Queue* q, int);
int dequeue(struct Queue* q);
int isEmpty(struct Queue* q);
```

Graph

Graph is a traditional implementation that holds a visited array and Adjacency list. Whenever an edge is added, adjList is rearranged accordingly. When the graph is fully loaded we can access the neighbours of a node by simply iteration over it’s linked list. initGraph method initializes this structure by reading it from the file. (Warning I assumed that the Node and Edge counts are provided at the 3. Line during this process).

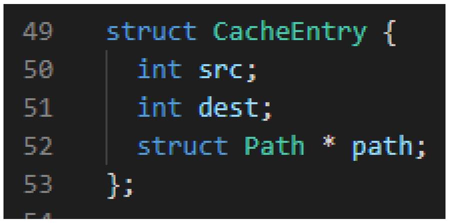
Cache

This structure works as a primitive hash map. It creates an index using a non-complex hash algorithm and saves the calculated paths.



```c
int calculateCacheHash(int src, int dest)
{
    return ((src * 2767) + (dest * 2767)) % CACHE_SIZE;
}
```

Paths can be overwritten so even if acquired path is not null, a check is necessary. That is why cache entries also have source and destination nodes.



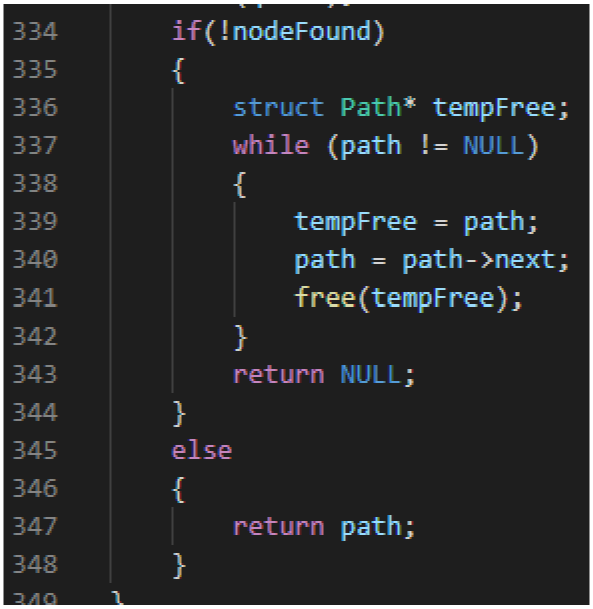
```c
struct CacheEntry {
    int src;
    int dest;
    struct Path * path;
};
```

METHODS

Methods that are not straightforward are explained here. Basic methods can be understood from the comments in the source code.

bfs()

This method creates a linked list and traverses the graph according to Breadth First algorithm while adding the visited nodes into this linked list. If it finds the destination node it returns the created linked list. If it cannot dinf the path it frees the linked list and returns NULL.



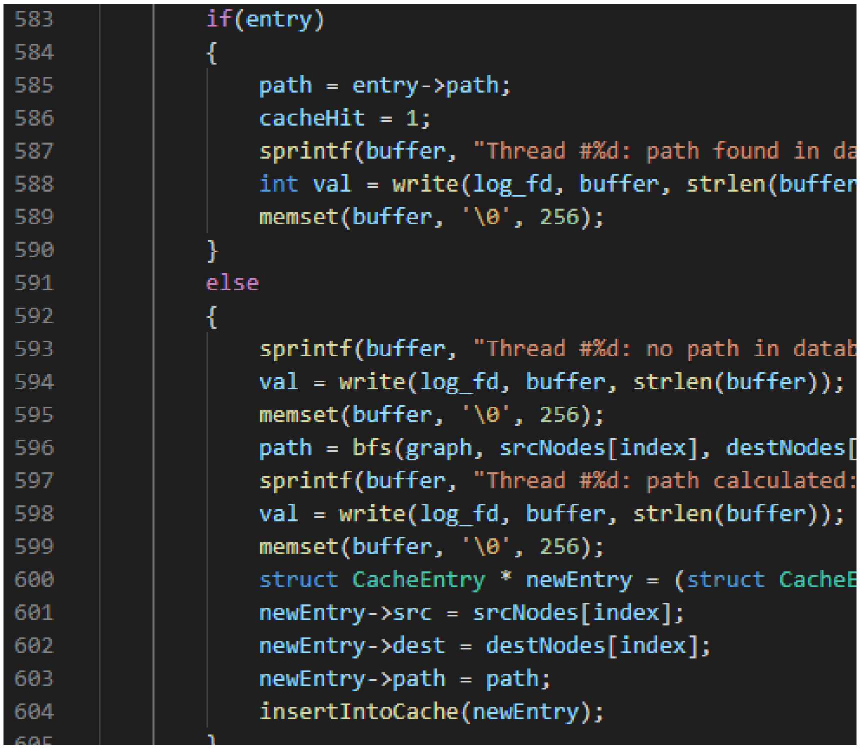
```c
    if(!nodeFound)
    {
        struct Path* tempFree;
        while (path != NULL)
        {
            tempFree = path;
            path = path->next;
            free(tempFree);
        }
        return NULL;
    }
    else
    {
        return path;
    }
}
```

assignTask()

Assigns the client to the first available thread. And awakes it.

requestHandler()

This is the worker thread function. At the beginning it tries to lock a mutex that is initially locked. When it is awaken by the assignTask function it first checks whether the server is shutting down or not. If it is not, it acquires the nodes and the socket assigned to global array at it’s index. It



```c
if(entry)
{
    path = entry->path;
    cacheHit = 1;
    sprintf(buffer, "Thread #%d: path found in da
    int val = write(log_fd, buffer, strlen(buffer
    memset(buffer, '\0', 256);
}
else
{
    sprintf(buffer, "Thread #%d: no path in datab
    val = write(log_fd, buffer, strlen(buffer));
    memset(buffer, '\0', 256);
    path = bfs(graph, srcNodes[index], destNodes[
    sprintf(buffer, "Thread #%d: path calculated:
    val = write(log_fd, buffer, strlen(buffer));
    memset(buffer, '\0', 256);
    struct CacheEntry * newEntry = (struct CacheE
    newEntry->src = srcNodes[index];
    newEntry->dest = destNodes[index];
    newEntry->path = path;
    insertIntoCache(newEntry);
}
```

first checks if the path is stored in db, if not it calls the bfs function. Afterwards it sends the path to the client node by node and if it calculated this path it stores the path into db

observer()

This is the observer thread function. It calculates the system load and calls expandThreads function if necessary.

APPROACH

-I created adjacency lists while loading the graph to drastically reduce the time spent by BFS function

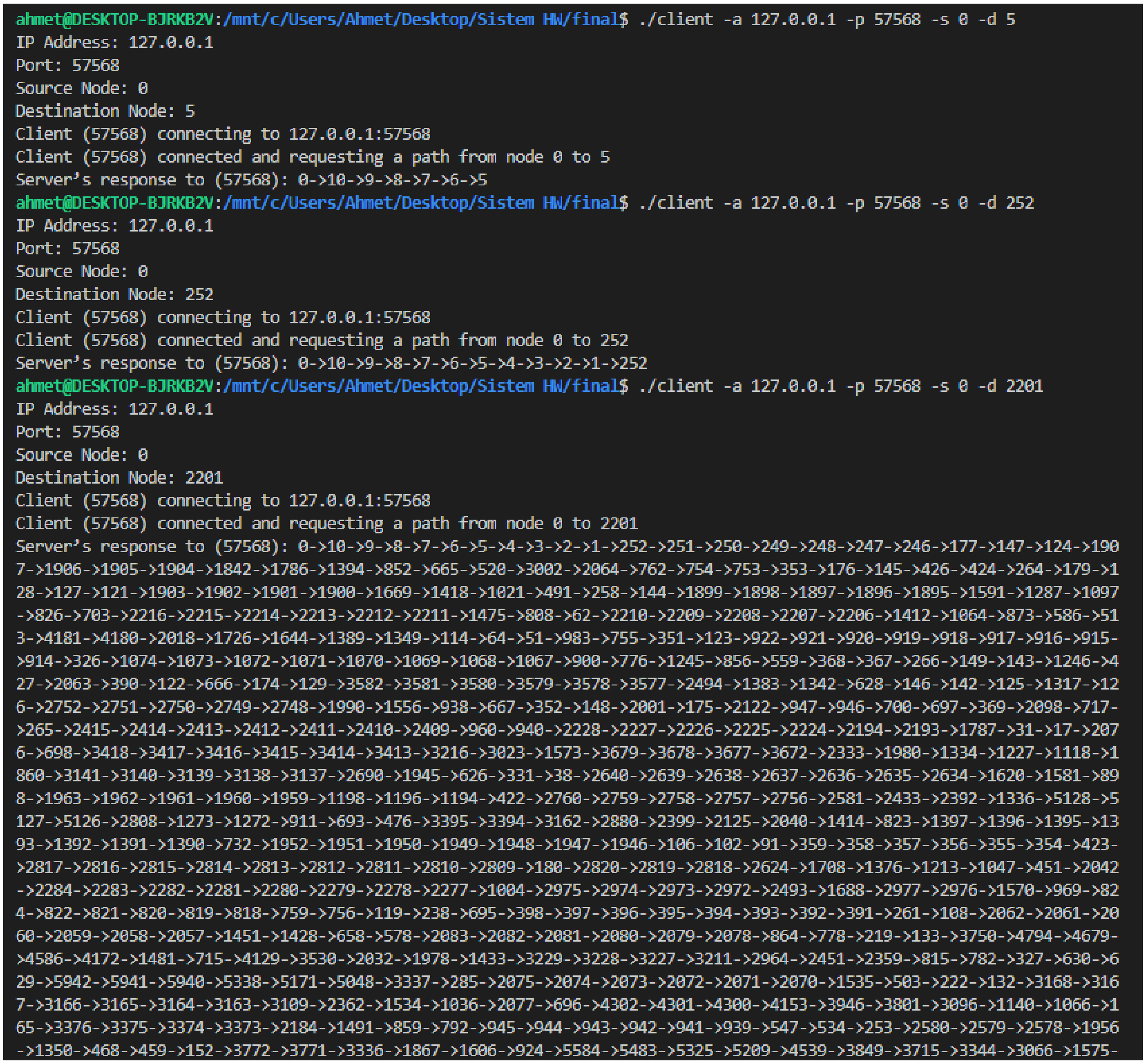
-I created a cache using hash algorithm to reduce time complexity to O(1).

TEST

I used the provided graph for testing. I started the server and made 3 queries

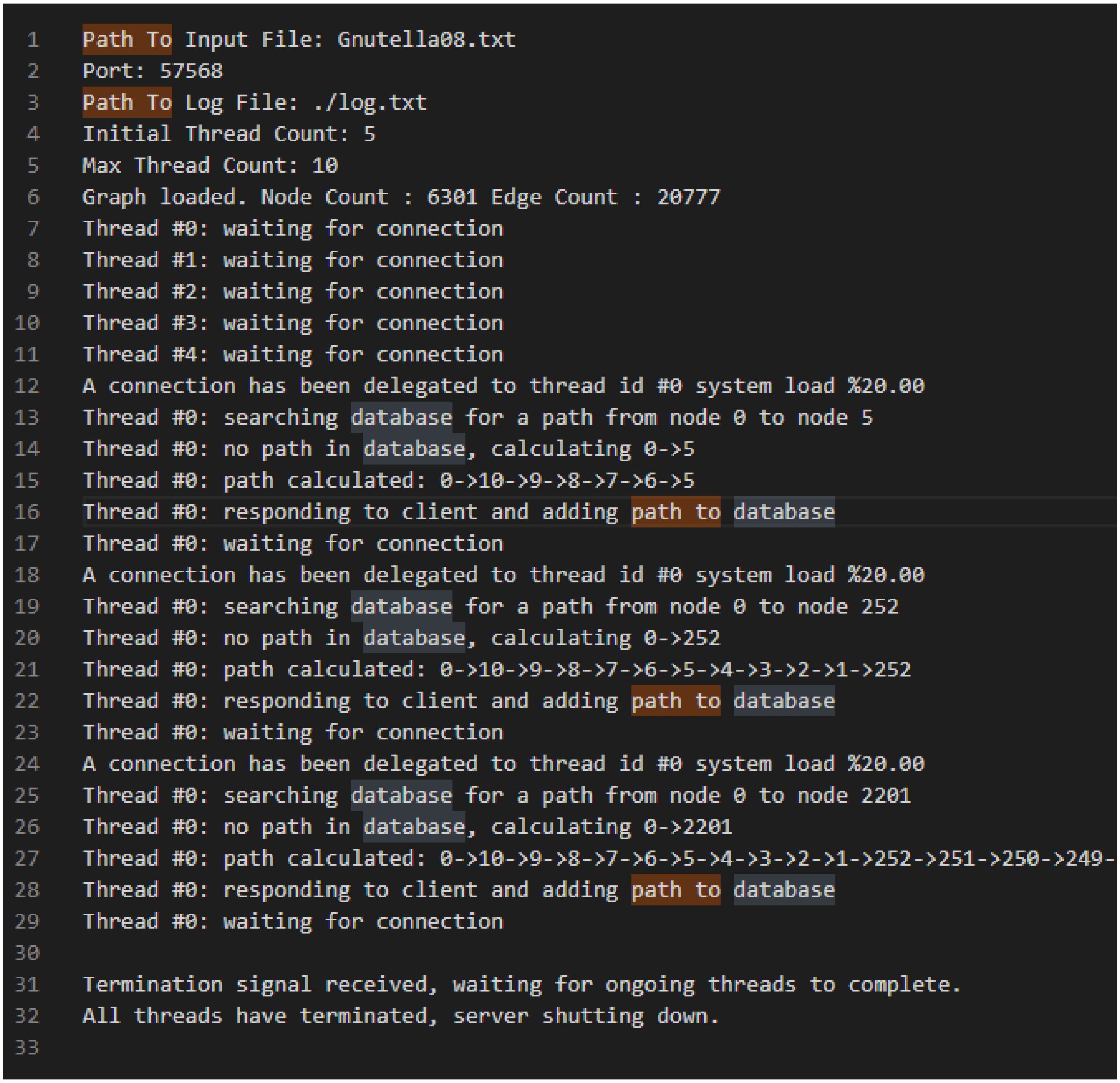
- 0 to 5
- 0 to 252
- 0 to 2201

Client Output:



```
ahmet@DESKTOP-BJRKB2V:/mnt/c/Users/Ahmet/Desktop/Sistem HW/final$ ./client -a 127.0.0.1 -p 57568 -s 0 -d 5
IP Address: 127.0.0.1
Port: 57568
Source Node: 0
Destination Node: 5
Client (57568) connecting to 127.0.0.1:57568
Client (57568) connected and requesting a path from node 0 to 5
Server’s response to (57568): 0->10->9->8->7->6->5
ahmet@DESKTOP-BJRKB2V:/mnt/c/Users/Ahmet/Desktop/Sistem HW/final$ ./client -a 127.0.0.1 -p 57568 -s 0 -d 252
IP Address: 127.0.0.1
Port: 57568
Source Node: 0
Destination Node: 252
Client (57568) connecting to 127.0.0.1:57568
Client (57568) connected and requesting a path from node 0 to 252
Server’s response to (57568): 0->10->9->8->7->6->5->4->3->2->1->252
ahmet@DESKTOP-BJRKB2V:/mnt/c/Users/Ahmet/Desktop/Sistem HW/final$ ./client -a 127.0.0.1 -p 57568 -s 0 -d 2201
IP Address: 127.0.0.1
Port: 57568
Source Node: 0
Destination Node: 2201
Client (57568) connecting to 127.0.0.1:57568
Client (57568) connected and requesting a path from node 0 to 2201
Server’s response to (57568): 0->10->9->8->7->6->5->4->3->2->1->252->251->250->249->248->247->246->177->147->124->190
7->1906->1905->1904->1842->1786->1394->852->665->520->3002->2064->762->754->753->353->176->145->426->424->264->179->1
28->127->121->1903->1902->1901->1900->1669->1418->1021->491->258->144->1899->1898->1897->1896->1895->1591->1287->1097
->826->703->2216->2215->2214->2213->2212->2211->1475->808->62->2210->2209->2208->2207->2206->1412->1064->873->586->51
3->4181->4180->2018->1726->1644->1389->1349->114->64->51->983->755->351->123->922->921->920->919->918->917->916->915-
>914->326->1074->1073->1072->1071->1070->1069->1068->1067->900->776->1245->856->559->368->367->266->149->143->1246->4
27->2063->390->122->666->174->129->3582->3581->3580->3579->3578->3577->2494->1383->1342->628->146->142->125->1317->12
6->2752->2751->2750->2749->2748->1990->1556->938->667->352->148->2001->175->2122->947->946->700->697->369->2098->717-
>265->2415->2414->2413->2412->2411->2410->2409->960->940->2228->2227->2226->2225->2224->2194->2193->1787->31->17->207
6->698->3418->3417->3416->3415->3414->3413->3216->3023->1573->3679->3678->3677->3672->2333->1980->1334->1227->1118->1
860->3141->3140->3139->3138->3137->2690->1945->626->331->38->2640->2639->2638->2637->2636->2635->2634->1620->1581->89
8->1963->1962->1961->1960->1959->1198->1196->1194->422->2760->2759->2758->2757->2756->2581->2433->2392->1336->5128->5
127->5126->2808->1273->1272->911->693->476->3395->3394->3162->2880->2399->2125->2040->1414->823->1397->1396->1395->13
93->1392->1391->1390->732->1952->1951->1950->1949->1948->1947->1946->106->102->91->359->358->357->356->355->354->423-
>2817->2816->2815->2814->2813->2812->2811->2810->2809->180->2820->2819->2818->2624->1708->1376->1213->1047->451->2042
->2284->2283->2282->2281->2280->2279->2278->2277->1004->2975->2974->2973->2972->2493->1688->2977->2976->1570->969->82
4->822->821->820->819->818->759->756->119->238->695->398->397->396->395->394->393->392->391->261->108->2062->2061->20
60->2059->2058->2057->1451->1428->658->578->2083->2082->2081->2080->2079->2078->864->778->219->133->3750->4794->4679-
>4586->4172->1481->715->4129->3530->2032->1978->1433->3229->3228->3227->3211->2964->2451->2359->815->782->327->630->6
29->5942->5941->5940->5338->5171->5048->3337->285->2075->2074->2073->2072->2071->2070->1535->503->222->132->3168->316
7->3166->3165->3164->3163->3109->2362->1534->1036->2077->696->4302->4301->4300->4153->3946->3801->3096->1140->1066->1
65->3376->3375->3374->3373->2184->1491->859->792->945->944->943->942->941->939->547->534->253->2580->2579->2578->1956
->1350->468->459->152->3772->3771->3336->1867->1606->924->5584->5483->5325->5209->4539->3849->3715->3344->3066->1575-
```

Server Log File



```
Path To Input File: Gnutella08.txt
Port: 57568
Path To Log File: ./log.txt
Initial Thread Count: 5
Max Thread Count: 10
Graph loaded. Node Count : 6301 Edge Count : 20777
Thread #0: waiting for connection
Thread #1: waiting for connection
Thread #2: waiting for connection
Thread #3: waiting for connection
Thread #4: waiting for connection
A connection has been delegated to thread id #0 system load %20.00
Thread #0: searching database for a path from node 0 to node 5
Thread #0: no path in database, calculating 0->5
Thread #0: path calculated: 0->10->9->8->7->6->5
Thread #0: responding to client and adding path to database
Thread #0: waiting for connection
A connection has been delegated to thread id #0 system load %20.00
Thread #0: searching database for a path from node 0 to node 252
Thread #0: no path in database, calculating 0->252
Thread #0: path calculated: 0->10->9->8->7->6->5->4->3->2->1->252
Thread #0: responding to client and adding path to database
Thread #0: waiting for connection
A connection has been delegated to thread id #0 system load %20.00
Thread #0: searching database for a path from node 0 to node 2201
Thread #0: no path in database, calculating 0->2201
Thread #0: path calculated: 0->10->9->8->7->6->5->4->3->2->1->252->251->250->249-
Thread #0: responding to client and adding path to database
Thread #0: waiting for connection

Termination signal received, waiting for ongoing threads to complete.
All threads have terminated, server shutting down.

```