Project Report

Title: Covid-19 Resource Delivery System

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SOFTWARES USED

1) **Visual Studio Code:**
Visual Studio Code is a free source-code editor made by Microsoft for Windows, Linux and macOS.

2) **GitBash:**
Git Bash is a source control management system for Windows. It allows users to type Git commands that make source code management easier through versioning and commit history.

3) **MinGW:**
It formerly mingw32,is free and open source software development environment to create Microsoft Windows application

4) **Github:** It makes it easy to contribute to your group work projects, It helps in documentation, It tracks changes in your code across versions

Dataset Description

1) Heaps: It will be used in Dijkstra's Algorithm

2) Linked List: It will be used in storing nodes of linked list.

3) Graphs: Used for making maps

4) Adjancency Matrix or Adjancency List: It will be used for graph storage

5) Other Datasets might be added as per the requirement while building the project code.

6) OOPS: used for storing information of various assets involved in the process.

Introduction:

“Covid-19 Resource Delivery System” formerly known as, Delivery System is a project designed to mainly generate the best and fastest route to supply Covid-19 Resources to the hospitals.

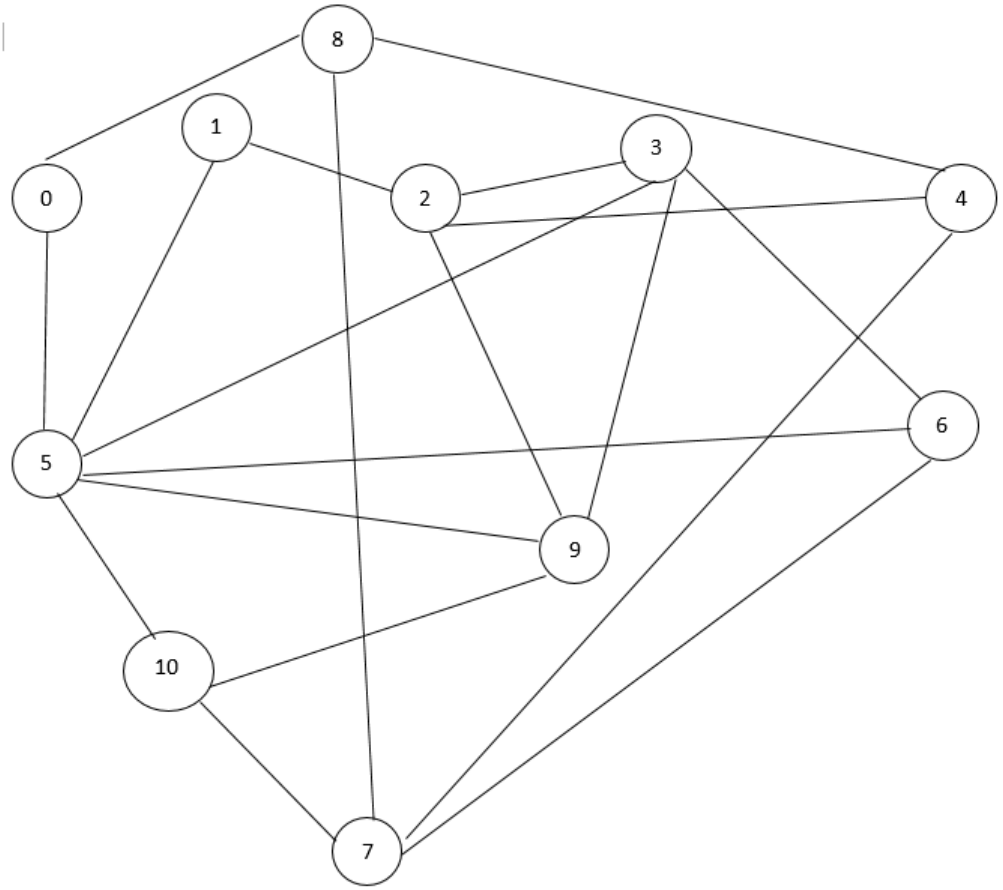
Objective and working of the code:

Basically, the code would be programmed in such a way that it is able to deliver us the required information, that is, the best and the most efficient route for the Covid-19 Resources to get delivered to the hospitals which are in need, from the nearest Warehouses.
In this project, we have considered the map of Noida, using Graphs Data Structures. We have taken 8 hospitals, and 3 warehouses where the Resources are stored.

Initially, the user would be asked for the Hospital’s name, where the resources are required. Then, the programme would ask for what resources are required in that hospital.

This is where the main objective of the code comes into play.
Now, the programme would display the best possible route from the Warehouse to the Hospital.
The Total Time taken for the resources to get delivered to their destined location would always be calculated and displayed.
The time shown would also consider all the traffics on these routes. This is done using Weighted Graphs of the maps.
And, The Traffic’s Congestion Level would be divided in 10 Levels, with Level 10 Traffic being the most congested one.

Graphical Representation of Noida City:



Code:

```
#include <iostream>
#include <ctime>

//Total assets including both hospitals and warehouse
#define Assets 11

using namespace std;

struct Information
{
    int Id;
    string Name, Address;
    string Type;
} Info[Assets] = {{0, "SJM", "Sector 63", "h"},
                  {1, "Prakash", "Sector 33", "h"},
                  {2, "Jaypee", "Sector 128", "h"},
                  {3, "Max", "Sector 19", "h"},
                  {4, "Yatharth", "Sector 110", "h"},
                  {5, "NMC", "Sector 30", "h"},
                  {6, "Kailash", "Sector 27", "h"},
                  {7, "Apollo", "Sector 26", "h"},
                  {8, "Singh", " Sector 4", " W "},
                  {9, "Mathura", "Sector 62", " W "},
                  {10, "Maheshwari", "Sector 69", "w"}};

// Data structure to store a graph edge
struct Node
{
    int Val;
    Information *Data;
    Node *Next;
    int Traffic;
};

// Function to print all neighboring vertices of a given vertex
void printList(Node *ptr)
{
    while (ptr != nullptr)
    {
        cout << " Road to ";
        if (ptr->Data->Type == "h")
            cout << "hospital -";
        else
            cout << "warehouse -";
```

```
            cout << ptr->Data->Name << " has traffic level " <<
ptr->Traffic << "\n";
        ptr = ptr->Next;
    }
    cout << endl;
}

// Data structure to store a graph edge
struct Edge
{
    int Source, Destination, Traffic;
};

class Graph
{
    // Function to allocate a new node for the adjacency list
    Node *GetAdjListNode(int Destination, Node *Head, int Traffic)
    {
        Node *newNode = new Node;
        newNode->Val = Destination;

        // point new node to the current Head
        newNode->Next = Head;
        newNode->Traffic = Traffic;
        newNode->Data = &Info[Destination];
        return newNode;
    }

    int N; // total number of nodes in the graph

public:
    // An array of pointers to Node to represent the
    // adjacency list
    Node **Head;

    // Constructor
    Graph(Edge Edges[], int n, int N)
    {
        // allocate memory
        Head = new Node *[N]();
        this->N = N;

        // initialize Head pointer for all vertices
        for (int i = 0; i < N; i++)
        {
            Head[i] = nullptr;
        }
```

```
        // add Edges to the directed graph
        for (unsigned i = 0; i < n; i++)
        {
            int Source = Edges[i].Source;
            int Destination = Edges[i].Destination;
            int Traffic = Edges[i].Traffic;
            // insert at the beginning
              Node *newNode = GetAdjListNode(Destination, Head[Source],
Traffic);

            // point Head pointer to the new node
            Head[Source] = newNode;

            // uncomment the following code for undirected graph

                    newNode  =  GetAdjListNode(Source,  Head[Destination],
Traffic);

            // change Head pointer to point to the new node
            Head[Destination] = newNode;
        }
    }

    void printGraph()
    {
        // print adjacency list representation of a graph
        for (int i = 0; i < N; i++)
        {
            // print given vertex
            cout << "Starting from " << Info[i].Name << ": \n";

            // print all its neighboring vertices
            printList(this->Head[i]);
        }
    }

    int findDestinationId(string name, int a, int b, int c) {
        for(int i = 0; i < Assets; i++) {
            if(Info[i].Name == name) {
                return Info[i].Id;
            }
        }
        return -1;
    }

    int Vertices() {
        return N;
    }
```

```
    // Destinationructor
    ~Graph()
    {
        for (int i = 0; i < N; i++)
        {
            delete[] Head[i];
        }

        delete[] Head;
    }
};

int random(int min, int max)
{
    int random_variable = rand();
    return min + (random_variable % (max - min + 1));
}

int convert(int val) {
    return 5*val;
}

// Structure to represent a min heap node
struct MinHeapNode
{
    int  v;
    int dist;
};

// Structure to represent a min heap
struct MinHeap
{

    // Number of heap nodes present currently
    int size;

    // Capacity of min heap
    int capacity;

    // This is needed for decreaseKey()
    int *pos;
    struct MinHeapNode **array;
};

// A utility function to create a
// new Min Heap Node
struct MinHeapNode* newMinHeapNode(int v,
                                   int dist)
```

```
{
    struct MinHeapNode* minHeapNode =
           (struct MinHeapNode*)
      malloc(sizeof(struct MinHeapNode));
    minHeapNode->v = v;
    minHeapNode->dist = dist;
    return minHeapNode;
}

// A utility function to create a Min Heap
struct MinHeap* createMinHeap(int capacity)
{
    struct MinHeap* minHeap =
         (struct MinHeap*)
      malloc(sizeof(struct MinHeap));
    minHeap->pos = (int *)malloc(
            capacity * sizeof(int));
    minHeap->size = 0;
    minHeap->capacity = capacity;
    minHeap->array =
         (struct MinHeapNode**)
                malloc(capacity *
       sizeof(struct MinHeapNode*));
    return minHeap;
}

// A utility function to swap two
// nodes of min heap.
// Needed for min heapify
void swapMinHeapNode(struct MinHeapNode** a,
                     struct MinHeapNode** b)
{
    struct MinHeapNode* t = *a;
    *a = *b;
    *b = t;
}

// A standard function to
// heapify at given idx
// This function also updates
// position of nodes when they are swapped.
// Position is needed for decreaseKey()
void minHeapify(struct MinHeap* minHeap,
                                  int idx)
{
    int smallest, left, right;
    smallest = idx;
    left = 2 * idx + 1;
```

```
    right = 2 * idx + 2;

    if (left < minHeap->size &&
        minHeap->array[left]->dist <
         minHeap->array[smallest]->dist )
      smallest = left;

    if (right < minHeap->size &&
        minHeap->array[right]->dist <
         minHeap->array[smallest]->dist )
      smallest = right;

    if (smallest != idx)
    {
        // The nodes to be swapped in min heap
        MinHeapNode *smallestNode =
             minHeap->array[smallest];
        MinHeapNode *idxNode =
                 minHeap->array[idx];

        // Swap positions
        minHeap->pos[smallestNode->v] = idx;
        minHeap->pos[idxNode->v] = smallest;

        // Swap nodes
        swapMinHeapNode(&minHeap->array[smallest],
                        &minHeap->array[idx]);

        minHeapify(minHeap, smallest);
    }
}

// A utility function to check if
// the given minHeap is ampty or not
int isEmpty(struct MinHeap* minHeap)
{
    return minHeap->size == 0;
}

// Standard function to extract
// minimum node from heap
struct MinHeapNode* extractMin(struct MinHeap*
                                    minHeap)
{
    if (isEmpty(minHeap))
        return NULL;

    // Store the root node
```

```
    struct MinHeapNode* root =
                  minHeap->array[0];

    // Replace root node with last node
    struct MinHeapNode* lastNode =
         minHeap->array[minHeap->size - 1];
    minHeap->array[0] = lastNode;

    // Update position of last node
    minHeap->pos[root->v] = minHeap->size-1;
    minHeap->pos[lastNode->v] = 0;

    // Reduce heap size and heapify root
    --minHeap->size;
    minHeapify(minHeap, 0);

    return root;
}

// Function to decreasy dist value
// of a given vertex v. This function
// uses pos[] of min heap to get the
// current index of node in min heap
void decreaseKey(struct MinHeap* minHeap,
                         int v, int dist)
{
    // Get the index of v in  heap array
    int i = minHeap->pos[v];

    // Get the node and update its dist value
    minHeap->array[i]->dist = dist;

    // Travel up while the complete
    // tree is not hepified.
    // This is a O(Logn) loop
    while (i && minHeap->array[i]->dist <
           minHeap->array[(i - 1) / 2]->dist)
    {
        // Swap this node with its parent
        minHeap->pos[minHeap->array[i]->v] =
                                       (i-1)/2;
        minHeap->pos[minHeap->array[
                              (i-1)/2]->v] = i;
        swapMinHeapNode(&minHeap->array[i],
                 &minHeap->array[(i - 1) / 2]);

        // move to parent index
        i = (i - 1) / 2;
```

```
    }
}

// A utility function to check if a given vertex
// 'v' is in min heap or not
bool isInMinHeap(struct MinHeap *minHeap, int v)
{
   if (minHeap->pos[v] < minHeap->size)
     return true;
   return false;
}


struct Warehouse {
    int Id;
    int dist;
};

// A utility function used to print the solution
void SmallestRoute(int dist[], int n, int src, int dest)
{
    cout<<"Time taken from warehouse " << Info[src].Name << " to reach
hospital  "<<  Info[dest].Name  <<  "  is  "  <<  convert(dist[dest])  <<  "
minutes." << endl;
}

// The main function that calculates
// distances of shortest paths from src to all
// vertices. It is a O(ELogV) function
Warehouse dijkstra(Graph* graph, int src, int dest)
{

    // Get the number of vertices in graph
    int V = graph->Vertices();

    // dist values used to pick
    // minimum weight edge in cut
    int dist[V];

    // minHeap represents set E
    struct MinHeap* minHeap = createMinHeap(V);

    // Initialize min heap with all
    // vertices. dist value of all vertices
    for (int v = 0; v < V; ++v)
    {
            dist[v] = INT32_MAX;
            minHeap->array[v] = newMinHeapNode(v, dist[v]);
```

```
        minHeap->pos[v] = v;
    }

    // Make dist value of src vertex
    // as 0 so that it is extracted first
    minHeap->array[src] =
          newMinHeapNode(src, dist[src]);
    minHeap->pos[src]   = src;
    dist[src] = 0;
    decreaseKey(minHeap, src, dist[src]);

    // Initially size of min heap is equal to V
    minHeap->size = V;

    // In the followin loop,
    // min heap contains all nodes
    // whose shortest distance
    // is not yet finalized.
    while (!isEmpty(minHeap))
    {
        // Extract the vertex with
        // minimum distance value
        struct MinHeapNode* minHeapNode =
                     extractMin(minHeap);

        // Store the extracted vertex number
        int u = minHeapNode->v;

        // Traverse through all adjacent
        // vertices of u (the extracted
        // vertex) and update
        // their distance values
        Node* pCrawl =
                     graph->Head[u];
        while (pCrawl != NULL)
        {
            int v = pCrawl->Val;

            // If shortest distance to v is
            // not finalized yet, and distance to v
            // through u is less than its
            // previously calculated distance
            if (isInMinHeap(minHeap, v) &&
                       dist[u] != INT32_MAX &&
              pCrawl->Traffic + dist[u] < dist[v])
            {
                dist[v] = dist[u] + pCrawl->Traffic;
```

```
                // update distance
                // value in min heap also
                decreaseKey(minHeap, v, dist[v]);
            }
            pCrawl = pCrawl->Next;
        }
    }

    // print the calculated shortest distances
    SmallestRoute(dist, V, src,dest);
        Warehouse w = {src, dist[dest]};
        return w;
}

Graph *CreateMap()
{

    Edge Edges[19] =
        {
            // pair `(x, y)` represents an edge from `x` to `y`
            {0, 5},
            {1, 5},
            {1, 2},
            {2, 3},
            {2, 4},
            {3, 5},
            {3, 6},
            {4, 7},
            {4, 8},
            {5, 9},
            {5, 10},
            {6, 5},
            {7, 6},
            {7, 10},
            {8, 7},
            {8, 0},
            {9, 2},
            {9, 3},
            {10, 9}};
    for (int i = 0; i < sizeof(Edges) / sizeof(Edges[0]); i++)
    {
        Edges[i].Traffic=random(1,10);
    }
    // total number of nodes in the graph
    int N = 11;

    // calculate the total number of Edges
    int n = 19;
```

```
    // construct graph
    Graph *Graphic = new Graph(Edges, n, N);

    return Graphic;
}

//--Graph implementation in C++ without using STL
int main()
{
       srand(time(nullptr));  //use current time as seed for random
generator

    Graph *G = CreateMap();

     cout << " -------- Welcome to Covid-19 Resource Delivery System
---------- \n\n";

    cout << "For the purpose of this demonstration, we have considered
8 hospitals and 3 warehouses\n";

    cout << "Details of the above is as follows : \n";

    for (int i = 0; i < Assets; i++)
    {
        if (Info[i].Type == "h")
        {
                    cout << "Hospital : " << Info[i].Name << ", " <<
Info[i].Address << endl;
        }
        else
        {
                   cout << "Warehouse : " << Info[i].Name << ", " <<
Info[i].Address << endl;
        }
    }
    cout << "\n";
    G->printGraph();

    cout << "Enter the name of hospital that require resources : ";
    string hospital;
    cin>>hospital;

    int a,b,c;
     cout << "Enter the required no of oxygen cylinders/concentrator :
";
    cin>>a;
    cout << "Enter the required no of PPE kit : ";
```

```
    cin>>b;
    cout << "Enter the required no of remdesivir : ";
    cin>>c;

    int dest = G->findDestinationId(hospital,a,b,c);
    cout<<endl;

    if(dest == -1) {
           cout<<"Invalid hospital name. Please enter a valid hospital
name."<<endl;
        return 0;
    }

    Warehouse fastest = {-1, INT32_MAX};

    for(int i=8; i<11; i++) {
        Warehouse temp = dijkstra(G, Info[i].Id,dest);
        if(temp.dist < fastest.dist)
            fastest = temp;
    }

     cout<<"\nAmong these, the most efficient warehouse for delivering
the required resources is : ";

    cout<< Info[fastest.Id].Name << endl;

    return 0;
}
```

Output of the code:

```
 -------- Welcome to Covid-19 Resource Delivery System -----------

For the purpose of this demonstration, we have considered 8 hospitals and 3 warehouses
Details of the above is as follows :
Hospital : SJM, Sector 63
Hospital : Prakash, Sector 33
Hospital : Jaypee, Sector 128
Hospital : Max, Sector 19
Hospital : Yatharth, Sector 110
Hospital : NMC, Sector 30
Hospital : Kailash, Sector 27
Hospital : Apollo, Sector 26
Warehouse : Singh,  Sector 4
Warehouse : Mathura, Sector 62
Warehouse : Maheshwari, Sector 69

Starting from SJM:
 Road to warehouse -Singh has traffic level 10
 Road to hospital -NMC has traffic level 1

Starting from Prakash:
 Road to hospital -Jaypee has traffic level 8
 Road to hospital -NMC has traffic level 5

Starting from Jaypee:
 Road to warehouse -Mathura has traffic level 9
 Road to hospital -Yatharth has traffic level 10
 Road to hospital -Max has traffic level 10
 Road to hospital -Prakash has traffic level 8

Starting from Max:
 Road to warehouse -Mathura has traffic level 9
 Road to hospital -Kailash has traffic level 9
 Road to hospital -NMC has traffic level 4
 Road to hospital -Jaypee has traffic level 10
```

```
Starting from Yatharth:
 Road to warehouse -Singh has traffic level 10
 Road to hospital -Apollo has traffic level 9
 Road to hospital -Jaypee has traffic level 10

Starting from NMC:
 Road to hospital -Kailash has traffic level 5
 Road to warehouse -Maheshwari has traffic level 4
 Road to warehouse -Mathura has traffic level 3
 Road to hospital -Max has traffic level 4
 Road to hospital -Prakash has traffic level 5
 Road to hospital -SJM has traffic level 1

Starting from Kailash:
 Road to hospital -Apollo has traffic level 10
 Road to hospital -NMC has traffic level 5
 Road to hospital -Max has traffic level 9

Starting from Apollo:
 Road to warehouse -Singh has traffic level 6
 Road to warehouse -Maheshwari has traffic level 3
 Road to hospital -Kailash has traffic level 10
 Road to hospital -Yatharth has traffic level 9

Starting from Singh:
 Road to hospital -SJM has traffic level 10
 Road to hospital -Apollo has traffic level 6
 Road to hospital -Yatharth has traffic level 10

Starting from Mathura:
 Road to warehouse -Maheshwari has traffic level 4
 Road to hospital -Max has traffic level 9
 Road to hospital -Jaypee has traffic level 9
 Road to hospital -NMC has traffic level 3

Starting from Maheshwari:
 Road to warehouse -Mathura has traffic level 4
 Road to hospital -Apollo has traffic level 3
 Road to hospital -NMC has traffic level 4
```

```
Enter the name of hospital that require resources : Apollo
Enter the required no of oxygen cylinders/concentrator : 100
Enter the required no of PPE kit : 124
Enter the required no of remdesivir : 15

Time taken from warehouse Singh to reach hospital Apollo is 30 minutes.
Time taken from warehouse Mathura to reach hospital Apollo is 35 minutes.
Time taken from warehouse Maheshwari to reach hospital Apollo is 15 minutes.

Among these, the most efficient warehouse for delivering the required resources is : Maheshwari
```

Incase the hospital the user would input is wrong, or that hospital does not exist, this output would be printed:

```
Enter the name of hospital that require resources : AIIMS
Enter the required no of oxygen cylinders/concentrator : 10
Enter the required no of PPE kit : 20
Enter the required no of remdesivir : 30

Invalid hospital name. Please enter a valid hospital name.
```