INTERNATIONAL ISLAMIC UNIVERSITY ISLAMABAD

Department of Software Engineering

Total Marks:

Obtained Marks:

Hospital Patient Queue System

A DSA Semester Project by Group 7

Semester: 4th

Subject: Data Structures & Algorithms

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Objective:

The objective of this project is to design and implement a hospital patient queue management system in C++ using efficient data structures and algorithms. The system manages patient data, maintains a queue based on priority, handles patient checkups, supports search and sort operations, and improves overall patient flow and data management efficiency.

Introduction:

Hospitals frequently face issues with long queues and inefficient patient handling, which can delay treatment and lower the quality of service. This project provides a software-based solution that prioritizes patients, based on medical urgency using a priority queue. It also allows doctors to manage patients effectively, search patient records, and give their best service.

Data Structures Used:

1. Priority Queue (Max-Heap)

⇒ **Implementation:** pQueue class using a vector as the underlying container.

⇒ **Purpose:** Ensures highest-priority patients (based on severity 1–10) are served first.

⇒ **Operations:** insert(), pop(), top().

2. Hash Table

⇒ **Implementation:** hTable class with linear probing (fixed size=35).

⇒ **Purpose:** Used for quick patient record lookup using a unique ID.

⇒ **Key Mechanism:** Patient ID hashing with collision resolution via linear probing.

3. Vector

⇒ **Purpose:** It stores served patients (checked list) for sorting/display.

Searching Algorithms Used:

Linear Search

⇒ **Use Case:** It is used to find a patient by ID in the checked patients list.

Binary Search

⇒ **Use Case:** Name-based search in the checked list after sorting by name.

⇒ **Prerequisite:** Requires selectSort() to pre-sort names.

Hash-Based Search

⇒ **Use Case:** Real-time patient lookup in the queue via ID.

⇒ **Code:** hTable::search() with linear probing.

Sorting Algorithms Used:

1. Quick Sort

⇒ **Use Case:** Sorting checked patients by age (ascending).

⇒ **Complexity:** $O(n \log n)$ best & average, $O(n^2)$ worst-case.

⇒ **Code:** quickSort() partitioning by age.

2. Selection Sort

⇒ **Use Case:** Sorting checked patients by name (ascending).

⇒ **Complexity:** O(n^2) all cases.

⇒ **Code:** selectSort() iteratively finds lexicographically smallest names.

3. Insertion Sort

⇒ **Use Case:** Sorting checked patients by checkup time (descending).

⇒ **Complexity:** O(n) best & O(n^2) average and worst.

⇒ **Code:** insertSort() swaps based on chkUpTime.

Core Functionalities:

⇒ Add new patient with automated ID generation.

⇒ Insert patient into the priority queue.

⇒ Display current patient queue.

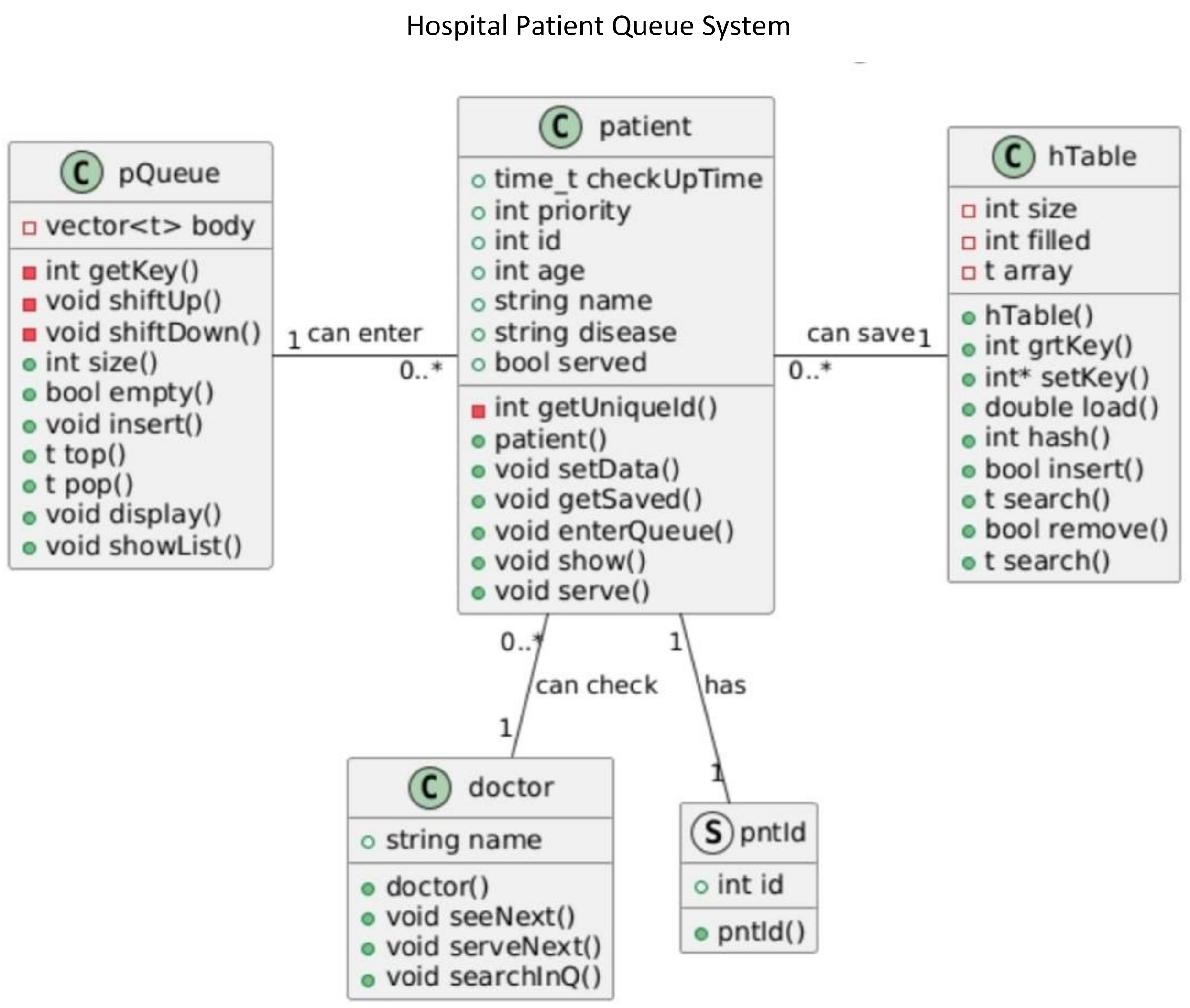
⇒ Doctor sees and serves next patient.

⇒ Maintain a checked patient list with checkup timestamp.

⇒ Sort and search functionalities on checked list.

⇒ Hash table for fast insert, search, and delete by ID.

Class Diagram:



Code:

```
#include<iostream>
#include<cstring>
#include<ctime>
#include<cstdlib>
#include<iomanip>
#include<vector>
#include<memory>

using namespace std;
template <class t>
class pQueue{
    vector<t> body;
    int getKey(t temp){
        return temp.priority;
    }
    void shiftUp(){
        int current=size()-1,parent;
        t temp;
           while(current>0){
            if(!current%2) parent=((current-2)/2);
            else parent=((current-1)/2);
            if(getKey(body[parent])<getKey(body[current])){
                temp=body[parent];
                body[parent]=body[current];
                body[current]=temp;
              }
             current=parent;
           }
    }
    void shiftDown(){
        int current=0,child;
        t temp;
        bool swap=false;
           while(current<size()-1){
            if((current*2+2<size())
                &&
                getKey(body[current*2+1])>getKey(body[current*2+2]))
                       child=(current*2+1);
            else if((current*2+2<size())
                    &&
                    getKey(body[current*2+2])>getKey(body[current*2+1]))
                        child=(current*2+2);
            else if(size()<3) child=current+1;
            if(getKey(body[child])>getKey(body[current])){
                temp=body[current];
                body[current]=body[child];
                body[child]=temp;
                swap=true;
              }
              if(!swap) break;
              swap=false;
             current=child;
          }
    }
    public:
    int  size(){
        return body.size();
    }
    bool empty(){
        return size()==0;
    }
    void insert(t a){
        body.push_back(a);
        shiftUp();
    }
    t   top(){
        t *empty=new t;
        if (size()==0) return *empty;
        delete empty;
        t x=body[0];
        return x;
    }
    t pop(){
        t *empty=new t;
        if (size()==0) return *empty;
        delete empty;
        t x=body[0];
        body[0]=body[size()-1];
        body.pop_back();
        shiftDown();
        return x;
    }
    void display(){
        for(int i=0;i<size();i++){
//          cout<<getKey(body[i])
            body[i].show();
            cout<<"\n\n\n";
        }
    }
    void showList(){
        cout<<left<<setw(5)<<"num"
                <<setw(7)<<"Id"
                <<setw(15)<<"Name"
                <<setw(10)<<"priority"
                <<setw(5)<<"Age"
                <<setw(15)<<"Disease"
                <<endl<<endl;
        for(int i=0;i<size();i++){
            cout<<left<<setw(5)<<i+1
                <<setw(7)<<body[i].id
                <<setw(15)<<body[i].name
                <<setw(10)<<body[i].priority
                <<setw(5)<<body[i].age
                <<setw(15)<<body[i].disease
                <<endl;
        }
    }
};
template <class t>
class hTable{
    int size=35,filled=0;
//  unique_ptr<t[]> array(new t[size]);
//  t *array=new t[size];;
    t array[35];

    void start(){
//      for (int i=0;i<size;i++)
//           array[i]= new t;
    }
    public:
        hTable(){}
//      hTable(int a){
//          size = a;
//          start();
//      }
        ~hTable(){
//          delete []array;
        }
        int getKey(t temp){
            return temp.id;
        }
        int* setKey(t &temp){
            return &temp.id;
        }
        double load(){
            return (static_cast<double>(filled)/static_cast<double>(size));
        }
        int hash(int a){
            return a%size;
        }
        bool insert(t realKey){
            int key=getKey(realKey);
            for (int i=0;i<size;i++){
            if(getKey(array[hash(key)])==-1){
                array[hash(key)]=realKey;
                filled++;
                return true;
               }
            key = key+i;
            }
            return false;
        }
        t search(int realKey){
            int key=realKey;
            for (int i=0;i<size;i++){
            if(getKey(array[hash(key)])==realKey){
                return array[hash(key)];
                 }
            key = key+i;
            }
            t *empty =new t;
            return *empty;
        }
        bool remove(t &realKey){
            int key=getKey(realKey);
            for (int i=0;i<size;i++){
            if(getKey(array[hash(key)])==getKey(realKey)){
                int *num=setKey(array[hash(key)]);
                *num=-1;
                filled--;
                return true;
                 }
            key = key+i;
            }
            return false;
        }
        void display(){
            for (int i=0;i<size;i++){
            if(getKey(array[i])!=-1){
                cout<<"value at index "
                    <<i<<" is "<<getKey(array[i])/*show()*/
                    <<"\n";
                 }
            }
        }
};
struct pntId{
    int id;
    pntId (){
         id = -1;
         }
    pntId (int a){
         id = a;
         }
};
class patient{
    int getUniqueId(hTable <pntId> &t){
            int a=(1000+(rand()%(10000-1000)));
            if(!(t.search(a)).id==-1){
               a = 1000+(rand()%(10000-1000));
            }
            pntId *b= new pntId(a);
            pntId p=*b;
            t.insert(p);
            return p.id;
            }
   public:
    time_t chkUpTime;
    int priority,id,age;
    string name,disease;
    bool served;
        patient(){
            priority = -1;
            id=-1;
            age=-1;
            name="unknown";
            disease="unknown";
            served=false;
        }
        patient(int a,int c,string d,string e,hTable<pntId> &IDs){
            priority = a;
            id=getUniqueId(IDs);
            age=c;
            name=d;
            disease=e;
            served=false;
        }
    void setData(hTable<pntId> &IDs){
            id=getUniqueId(IDs);
            cout<<"\ngenerated id: "<<id;
            cout<<"\nenter name: ";
            cin>>name;
            cout<<"enter age: ";
            cin>>age;
        while(!(age>=1&&age<=149)){
            cout<<"\ninvalid INPUT. \n enter again";
            cin>>age;
      }
            cout<<"enter disease: ";
            cin>>disease;
            cout<<"enter priority:(1 to 10) ";
            cin>>priority;
        while(!(priority>=1&&priority<=10)){
            cout<<"\ninvalid INPUT. \n enter again";
            cin>>priority;
      }
        }
    void getSaved(hTable<patient> &t){
            if(t.insert(*this)) cout<<"entered table";
            else cout<<"can't enter table";
        }
    void enterQueue(pQueue<patient>& q,hTable<patient> &t){
        q.insert(*this);
        t.insert(*this);
    }
    void show(){
        cout<<"\nname: "<<name;
        cout<<"\nage: "<<age;
        cout<<"\nid: "<<id;
        cout<<"\npriority: "<<priority;
        cout<<"\nserved :"<<served;
        if(served)
        cout<<"\nserved at: "<<put_time(localtime(&chkUpTime),"%Y-%m-%d-
%H:%M:%S");
        cout<<"\n";
    }
    void serve(){
        chkUpTime=time(0);
        served=true;
    }
};
class doctor{
    public:
        string name;
        doctor(string n){
           name= n;
        }
        void seeNext(pQueue<patient> &q){
            patient p=q.top();
            p.show();
        }
        void serveNext(pQueue<patient> &q,hTable<patient> &t1,vector<patient>
&chkd){
            patient p=q.pop();
            t1.remove(p);
            p.serve();
            chkd.push_back(p);
        }
        void searchInQ(hTable<patient> &t){
            patient p;
            int a;
            cout<<"\nenter id to search:";
            cin>>a;
        while(!(a>=1000&&a<=9999)){
            cout<<"\ninvalid id. \n enter again";
            cin>>a;
      }
            p=t.search(a);
            if(p.id==-1) cout <<"\nnot found\n";
            else {
            cout <<"\nfound in queue\n";
            p.show();
            }
        }
};
int qSort(vector<patient> &a,int min,int max){
    int pos=min;
    patient temp;
    for (int i=min;i<=max;i++){
        if(a[i].age<=a[max].age){
        temp=a[i];
        a[i]=a[pos];
        a[pos]=temp;
        pos++;
    }
    }
    return pos-1;
}
void quickSort(vector<patient> &a,int min,int max){
    if(min>=max)
         return;
      int pivot = qSort(a,min,max);
      quickSort(a,min,pivot-1);
      quickSort(a,pivot+1,max);
}
void insertSort(vector<patient> &a,int max){
    patient temp;
    for (int i=0;i<max;i++){
       for(int j=i;j>0;j--){
        if(a[j].chkUpTime>a[j-1].chkUpTime){
            temp=a[j-1];
            a[j-1]=a[j];
            a[j]=temp;
         }
         else
             break;
     }
   }
}
void selectSort(vector<patient> &a,int max){
    patient min,temp;
    int loc;
    for (int i=0;i<max;i++){

        min=a[i];
        loc=i;

       for(int j=i+1;j<max;j++){
        if(a[j].name<min.name){
            min=a[j];
            loc=j;
         }
         }
         temp=a[i];
         a[i]=a[loc];
         a[loc]=temp;

   }
}
int binarySearch(vector<patient> &a,string val){
    int size=a.size(), low=0, high=size-1 ,mid;

    while(low<=high){
        mid=low+(high-low)/2;
        if(a[mid].name==val)
           return mid;
        else if(a[mid].name<val)
           low = mid+1;
        else
           high=mid-1;
    }
    return -1;
}
int main(){
 cout<<"Bismillah hirrehman nirraheem\n";
```

```
srand(static_cast<int>(time(0)));
hTable<pntId> IDs;
hTable<patient> inQueue;
pQueue<patient> q1;
doctor dctr("Dr.Kamal");
vector<patient> checked;
int choice,choice2,b,c;
char s;

patient p1(7,15,"ali","fever",IDs);
patient p2(10,23,"bilal","injury",IDs);
patient p3(5,17,"saad","cough",IDs);
patient p4(3,19,"khalid","itching",IDs);
patient p5(1,14,"jaffer","flu",IDs);
patient p6(7,15,"karam","fever",IDs);
patient p7(10,28,"raza","injury",IDs);
patient p8(5,27,"hashim","cough",IDs);
patient p9(3,29,"khurshid","itching",IDs);
patient p10(1,5,"zia","flu",IDs);
patient p11(7,11,"wasee","fever",IDs);
patient p12(10,23,"umer","injury",IDs);
patient p13(5,7,"toqeer","cough",IDs);
patient p14(3,9,"nadir","itching",IDs);
patient p15(1,16,"fahad","flu",IDs);
patient p16(1,5,"yasir","flu",IDs);
patient p17(7,11,"wajih","fever",IDs);
patient p18(10,23,"qarir","injury",IDs);
patient p19(5,7,"qamar","cough",IDs);
patient p20(3,9,"nasir","itching",IDs);
patient p21(1,16,"javed","flu",IDs);

time_t smplTime=time(0);

p1.chkUpTime=smplTime-2500;
p2.chkUpTime=smplTime-4200;
p3.chkUpTime=smplTime-6900;
p4.chkUpTime=smplTime-8600;
p5.chkUpTime=smplTime-1000;
p6.chkUpTime=smplTime-1700;
p7.chkUpTime=smplTime-3300;
p8.chkUpTime=smplTime-2700;
p9.chkUpTime=smplTime-3900;
```

```
p10.chkUpTime=smplTime-1500;
p11.chkUpTime=smplTime-5300;
p12.chkUpTime=smplTime-3700;
p13.chkUpTime=smplTime-4900;

checked.push_back(p1);
checked.push_back(p2);
checked.push_back(p3);
checked.push_back(p4);
checked.push_back(p5);
checked.push_back(p6);
checked.push_back(p7);
checked.push_back(p8);
checked.push_back(p9);
checked.push_back(p10);
checked.push_back(p11);
checked.push_back(p12);
checked.push_back(p13);

p14.enterQueue(q1,inQueue);
p15.enterQueue(q1,inQueue);
p16.enterQueue(q1,inQueue);
p17.enterQueue(q1,inQueue);
p18.enterQueue(q1,inQueue);
p19.enterQueue(q1,inQueue);
p20.enterQueue(q1,inQueue);
p21.enterQueue(q1,inQueue);

do{
 system("cls");
 cout<<"Bismillah hirrehman nirraheem\n";
 cout<<"\n PATIENT QUEUE MANAGEMENT   \n\n";
 cout<<"\nEnter 1 to add new new patient"
     <<"\nEnter 2 to check next patient"
     <<"\nEnter 3 to find in queue"
     <<"\nEnter 4 to view patients of queue"
     <<"\nEnter 5 to view doctor name"
     <<"\nEnter 6 to view checked list"
     <<"\nEnter 7 to sort checked list"
     <<"\nEnter 8 to search by id"
     <<"\nEnter 9 to search by name"
     <<" \n your choice : ";
```

```
      cin>>choice;
      while(!(choice>=1&&choice<=9)){
        cout<<"\ninvalid choice. \n enter again";
        cin>>choice;
      }
switch(choice) {
   case 1 :{
       system("cls");
       cout<<"NEW PATIENT\n";
       patient *a=new patient;
       patient p=*a;
       p.setData(IDs);
       p.enterQueue(q1,inQueue);
    break;
   }
   case 2 :{
       system("cls");
       cout<<"CHECKUP ROOM\n";
       cout<<"\npatient being checked :\n";
       dctr.seeNext(q1);
       cout<<"\npatient got checked ?(y)";
       cin>>s;
       while(!(s=='y'||s=='Y')){
       cout<<"\ninvalid input. \n enter y or Y";
       cin>>s;
     }
       dctr.serveNext(q1,inQueue,checked);
    break;
   }
   case 3 :{
       system("cls");
       cout<<"QUEUE SEARCH\n";
       dctr.searchInQ(inQueue);
    break;
   }
   case 4 :{
       system("cls");
       cout<<"QUEUE LIST\n";
       q1.showList();
    break;
   }
   case 5 :{
        system("cls");
        cout<<"THE DOCTOR\n";
        cout<<"\n your doctoer's name is :"<<dctr.name;
     break;
    }
    case 6 :{
        system("cls");
        cout<<"CHECKED PATIENTS LIST\n";
        cout<<left<<setw(5)<<"num"
                <<setw(7)<<"Id"
                <<setw(15)<<"Name"
                <<setw(5)<<"Age"
                <<setw(15)<<"Disease"
                <<setw(35)<<"Date & Time of checkup"
                <<endl
                <<endl;
        for(int i=0;i<checked.size();i++){
            cout<<left<<setw(5)<<i+1
                <<setw(7)<<checked[i].id
                <<setw(15)<<checked[i].name
                <<setw(5)<<checked[i].age
                <<setw(15)<<checked[i].disease
                <<setw(35)<<put_time(localtime(&checked[i].chkUpTime),"%Y-%m-
%d    %H:%M:%S")
                <<endl;
        }
     break;
    }
    case 7 :{
        system("cls");
        cout<<"SORTING\n";
    cout<<"\nEnter 1 to sort by age"
        <<"\nEnter 2 to sort by name"
        <<"\nEnter 3 to sort by time"
        <<" \n your choice : ";
        cin>>choice2;
        while(!(choice2>=1&&choice2<=3)){
        cout<<"\ninvalid choice. \n enter again";
        cin>>choice2;
      }
    switch(choice2) {
        case 1:{
            quickSort(checked,0,checked.size()-1);
            break;
        }
        case 2:{
            selectSort(checked,checked.size());
            break;
        }
        case 3:{
            insertSort(checked,checked.size());
            break;
        }
        default :{
            break;
        }
    }
        cout<<"sorted";
     break;
    }
    case 8 :{
        system("cls");
        cout<<"ID SEARCH\n";
        int tmpId;
        bool found=false;
        cout<<"\nenter Id :";
        cin>>tmpId;
        while(!(tmpId>=1000&&tmpId<=9999)){
            cout<<"\ninvalid id. \n enter again";
            cin>>tmpId;
      }
        for(int i=0;i<checked.size();i++){
            if(tmpId==checked[i].id){

                 checked[i].show();
                 found=true;
                 }
        }
        if(!found)
        cout<<"\nnot found";
     break;
    }
    case 9 :{
        system("cls");
        cout<<"NAME SEARCH\n";
        string tmpname;
        int index;
        cout<<"\nenter name :";
        cin>>tmpname;
        selectSort(checked,checked.size());
        index=binarySearch(checked,tmpname);
        if(index==-1)cout<<"\nnot found";
        else checked[index].show();
     break;
    }
    default:
        break;
}
 cout<<"\nenter 0 to quit and 1 to go back: ";
 cin>>c;
 }while (!c==0);
 return 0;
 }
```

Implementation Overview:

1. Initialization:

⇒ hTable <pntId> ensures unique patient IDs.

⇒ Sample patients pre-loaded into pQueue and checked for testing.

2. Main Menu:

⇒ 9 interactive options (add patient, serve next, search, display, sort, etc.).

3. Patient Flow:

⇒ New patients: Added to pQueue and hTable.

⇒ Served patients: Moved from pQueue to checked vector with timestamp.

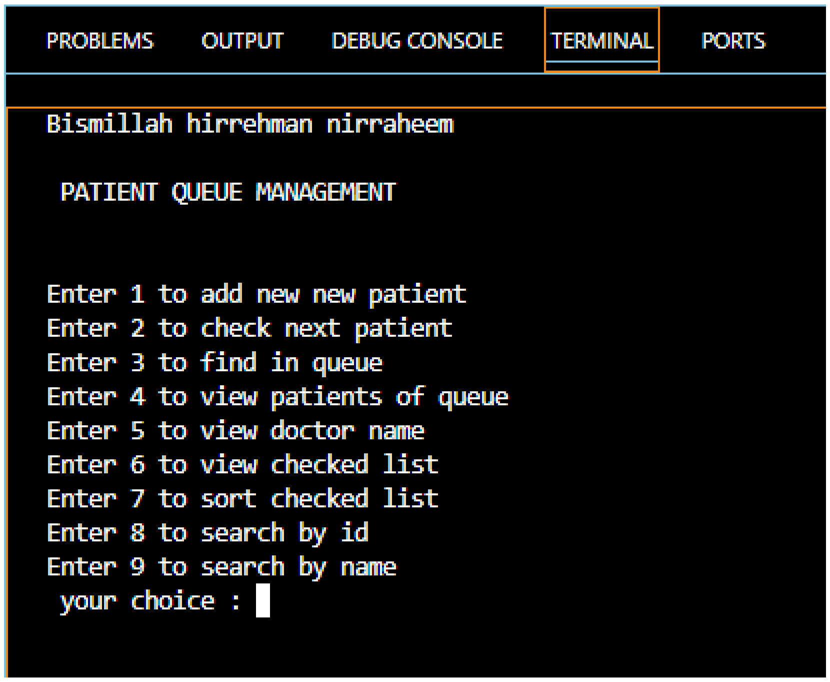
4. Data Query:

⇒ Sorting: Triggered via quickSort(), selectSort(), or insertSort().

⇒ Searching: Hash table (active queue) or linear/binary search (checked list).

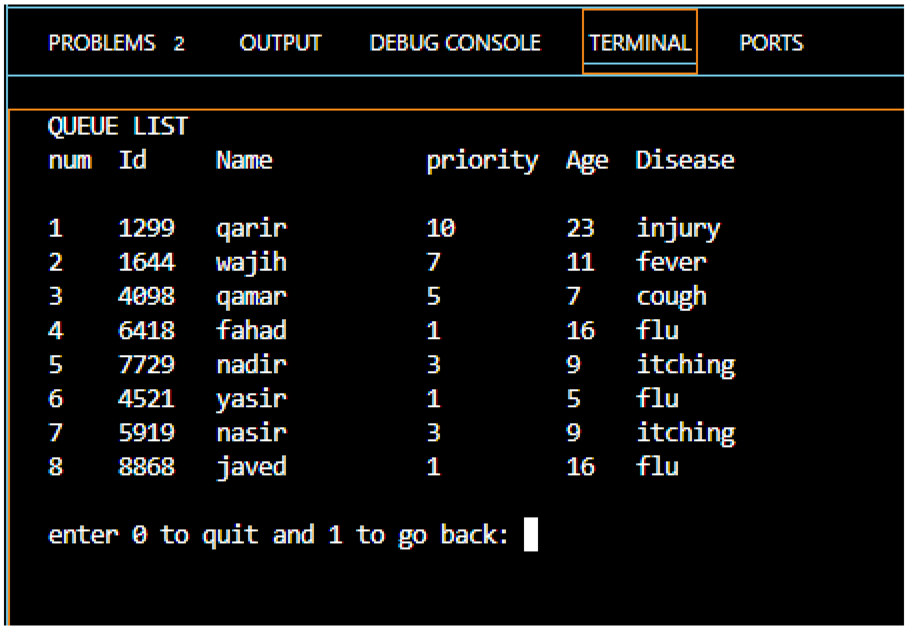
Screenshots of System's Working:

Main Menu:



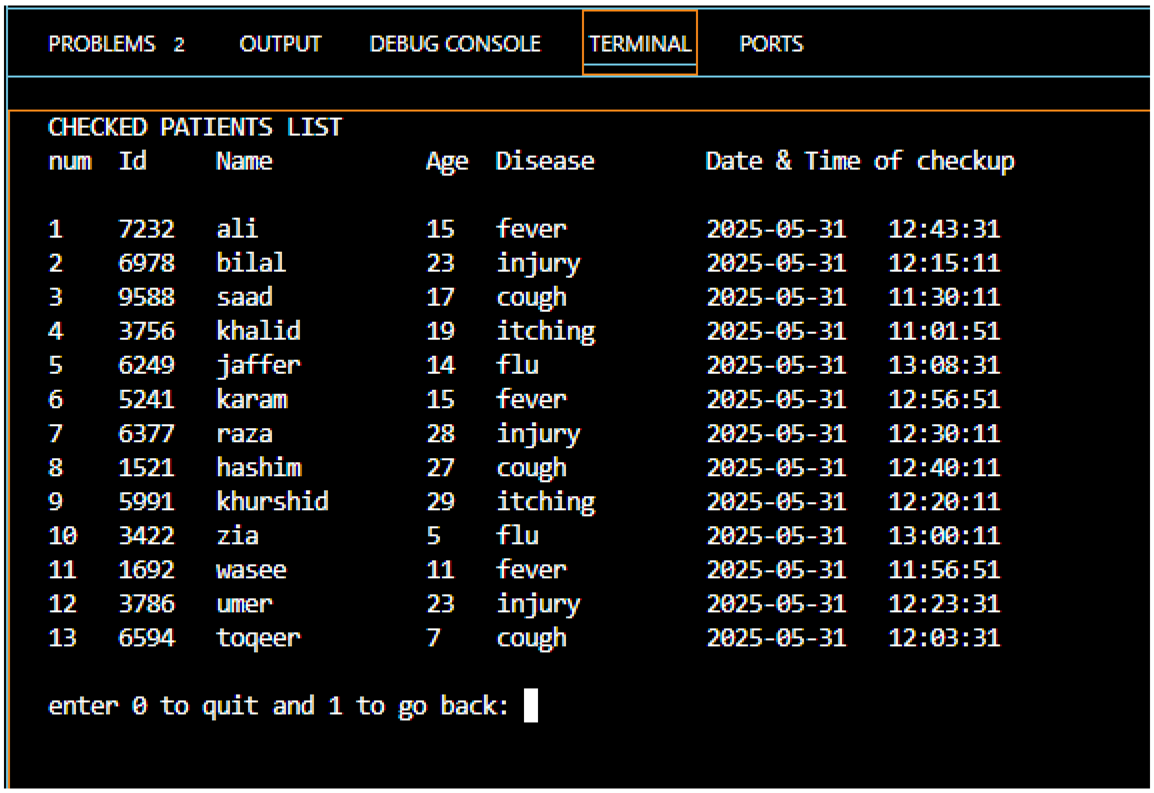
```
Bismillah hirrehman nirraheem

 PATIENT QUEUE MANAGEMENT


Enter 1 to add new new patient
Enter 2 to check next patient
Enter 3 to find in queue
Enter 4 to view patients of queue
Enter 5 to view doctor name
Enter 6 to view checked list
Enter 7 to sort checked list
Enter 8 to search by id
Enter 9 to search by name
 your choice :
```

Initial Queue List:



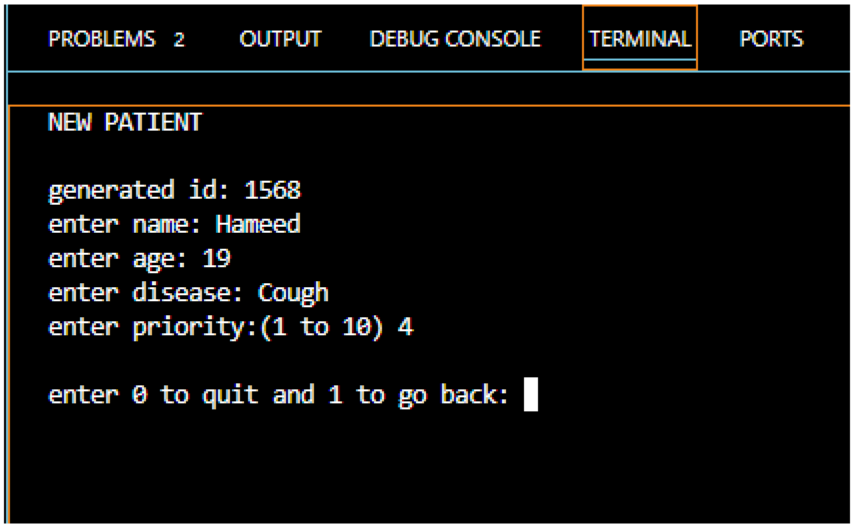
```
QUEUE LIST
num  Id      Name           priority  Age  Disease

1    1299    qarir          10        23   injury
2    1644    wajih          7         11   fever
3    4098    qamar          5         7    cough
4    6418    fahad          1         16   flu
5    7729    nadir          3         9    itching
6    4521    yasir          1         5    flu
7    5919    nasir          3         9    itching
8    8868    javed          1         16   flu

enter 0 to quit and 1 to go back:
```

Initial Checked Patients list:



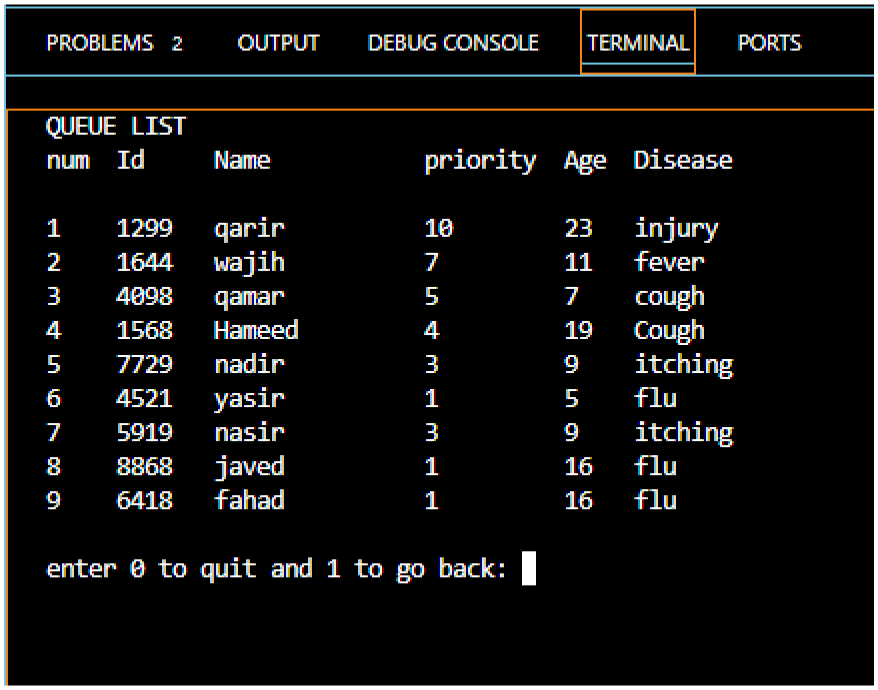
```
CHECKED PATIENTS LIST
num  Id     Name          Age  Disease       Date & Time of checkup

1    7232   ali           15   fever         2025-05-31   12:43:31
2    6978   bilal         23   injury        2025-05-31   12:15:11
3    9588   saad          17   cough         2025-05-31   11:30:11
4    3756   khalid        19   itching       2025-05-31   11:01:51
5    6249   jaffer        14   flu           2025-05-31   13:08:31
6    5241   karam         15   fever         2025-05-31   12:56:51
7    6377   raza          28   injury        2025-05-31   12:30:11
8    1521   hashim        27   cough         2025-05-31   12:40:11
9    5991   khurshid      29   itching       2025-05-31   12:20:11
10   3422   zia           5    flu           2025-05-31   13:00:11
11   1692   wasee         11   fever         2025-05-31   11:56:51
12   3786   umer          23   injury        2025-05-31   12:23:31
13   6594   toqeer        7    cough         2025-05-31   12:03:31

enter 0 to quit and 1 to go back: 
```

Adding New Patient



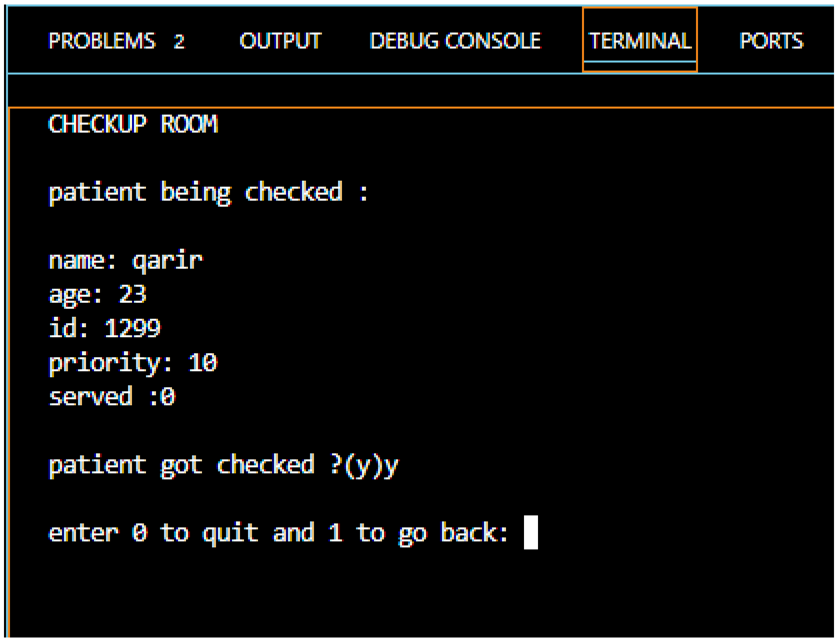
```
NEW PATIENT

generated id: 1568
enter name: Hameed
enter age: 19
enter disease: Cough
enter priority:(1 to 10) 4

enter 0 to quit and 1 to go back:
```

Queue list After adding New Patient:



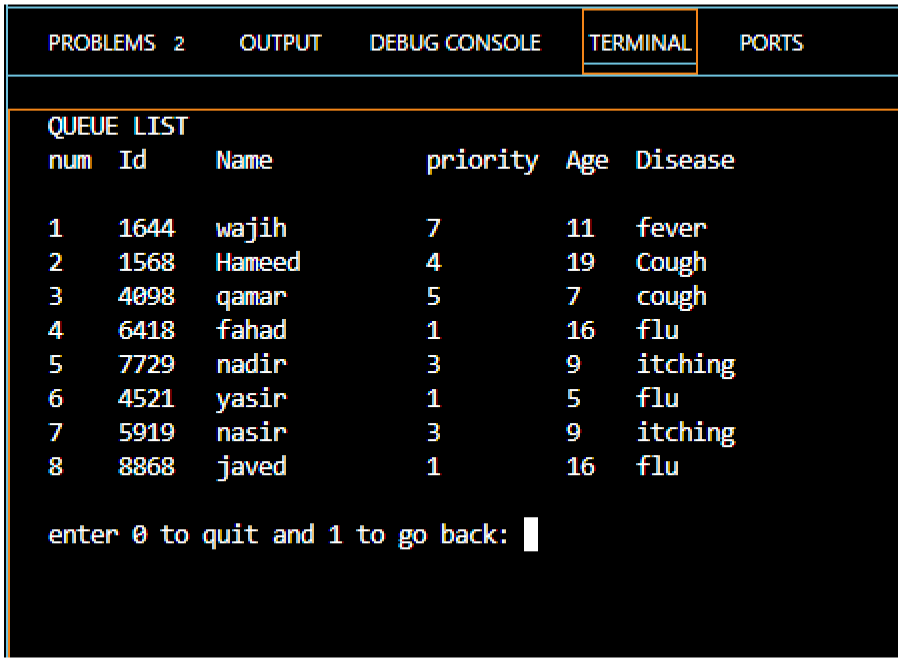
```
QUEUE LIST
num  Id     Name          priority  Age  Disease

1    1299   qarir         10        23   injury
2    1644   wajih         7         11   fever
3    4098   qamar         5         7    cough
4    1568   Hameed        4         19   Cough
5    7729   nadir         3         9    itching
6    4521   yasir         1         5    flu
7    5919   nasir         3         9    itching
8    8868   javed         1         16   flu
9    6418   fahad         1         16   flu

enter 0 to quit and 1 to go back:
```

Checking a Patient:



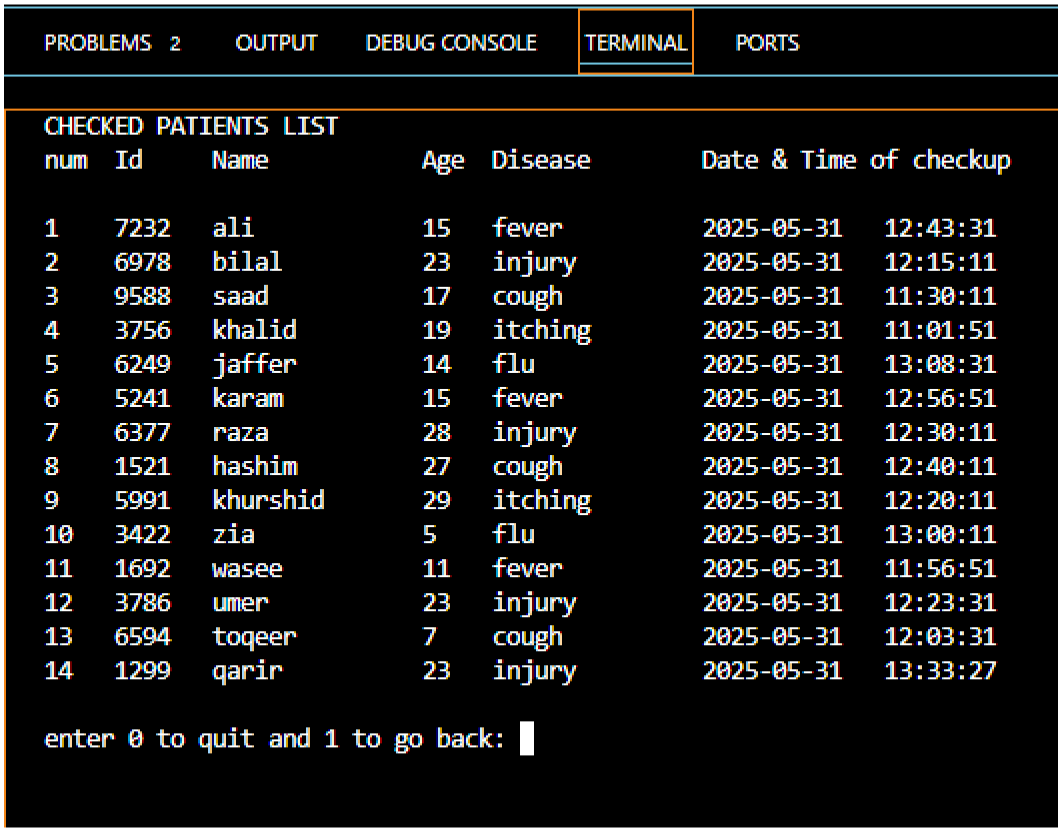
```
CHECKUP ROOM

patient being checked :

name: qarir
age: 23
id: 1299
priority: 10
served :0

patient got checked ?(y)y

enter 0 to quit and 1 to go back:
```

Queue list After Checking one Patient:



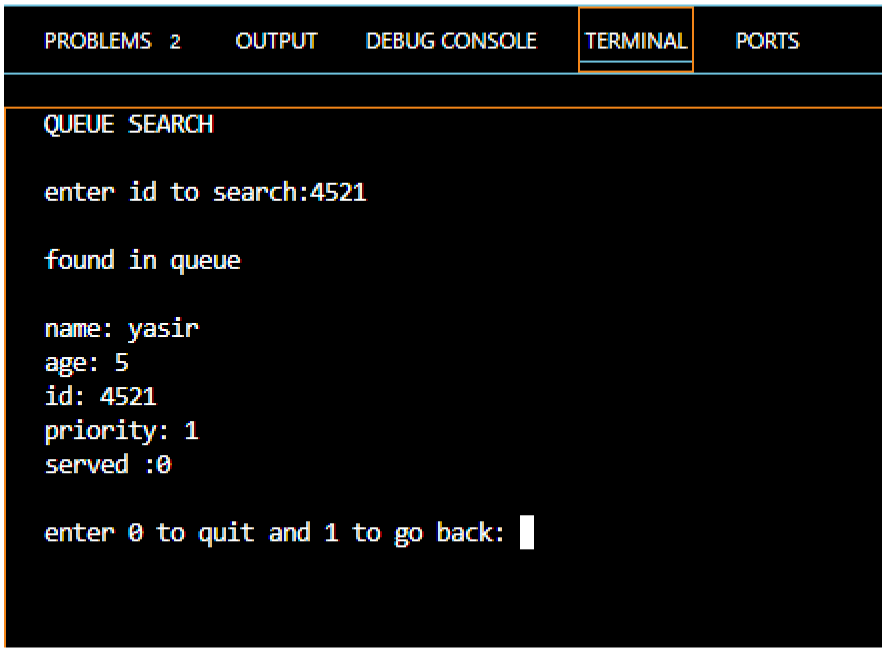
```
QUEUE LIST
num  Id     Name          priority  Age  Disease

1    1644   wajih         7         11   fever
2    1568   Hameed        4         19   Cough
3    4098   qamar         5         7    cough
4    6418   fahad         1         16   flu
5    7729   nadir         3         9    itching
6    4521   yasir         1         5    flu
7    5919   nasir         3         9    itching
8    8868   javed         1         16   flu

enter 0 to quit and 1 to go back:
```

Checked Patients list After checking one Patient:


PROBLEMS 2 OUTPUT DEBUG CONSOLE TERMINAL PORTS

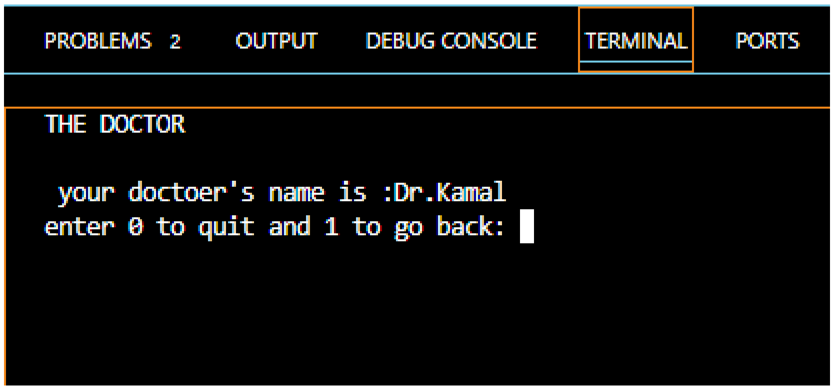
```
CHECKED PATIENTS LIST
num  Id    Name          Age  Disease        Date & Time of checkup

1    7232  ali           15   fever          2025-05-31   12:43:31
2    6978  bilal         23   injury         2025-05-31   12:15:11
3    9588  saad          17   cough          2025-05-31   11:30:11
4    3756  khalid        19   itching        2025-05-31   11:01:51
5    6249  jaffer        14   flu            2025-05-31   13:08:31
6    5241  karam         15   fever          2025-05-31   12:56:51
7    6377  raza          28   injury         2025-05-31   12:30:11
8    1521  hashim        27   cough          2025-05-31   12:40:11
9    5991  khurshid      29   itching        2025-05-31   12:20:11
10   3422  zia           5    flu            2025-05-31   13:00:11
11   1692  wasee         11   fever          2025-05-31   11:56:51
12   3786  umer          23   injury         2025-05-31   12:23:31
13   6594  toqeer        7    cough          2025-05-31   12:03:31
14   1299  qarir         23   injury         2025-05-31   13:33:27

enter 0 to quit and 1 to go back:
```

Find/Search a Patient in Queue:



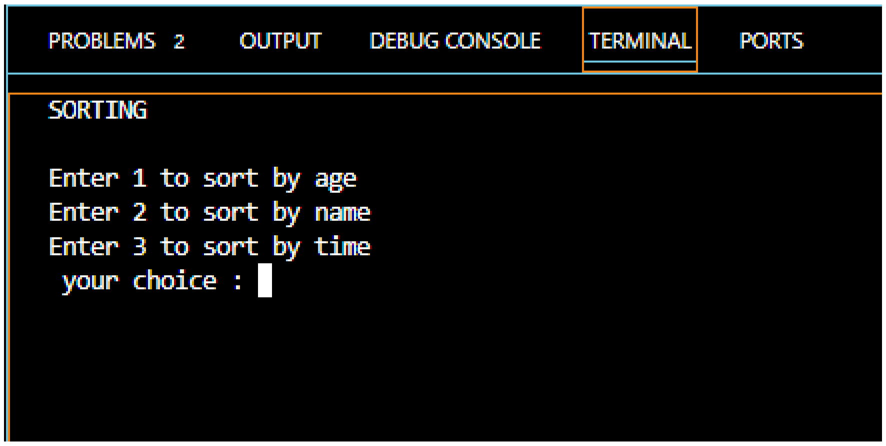
```
QUEUE SEARCH

enter id to search:4521

found in queue

name: yasir
age: 5
id: 4521
priority: 1
served :0

enter 0 to quit and 1 to go back:
```

View Doctor's name:



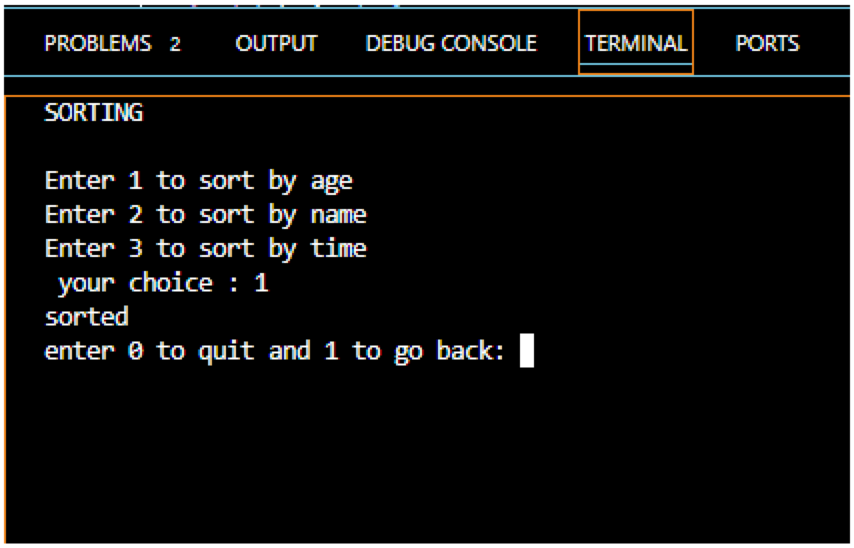
```
THE DOCTOR

 your doctoer's name is :Dr.Kamal
enter 0 to quit and 1 to go back:
```

Sort Checked Patients:



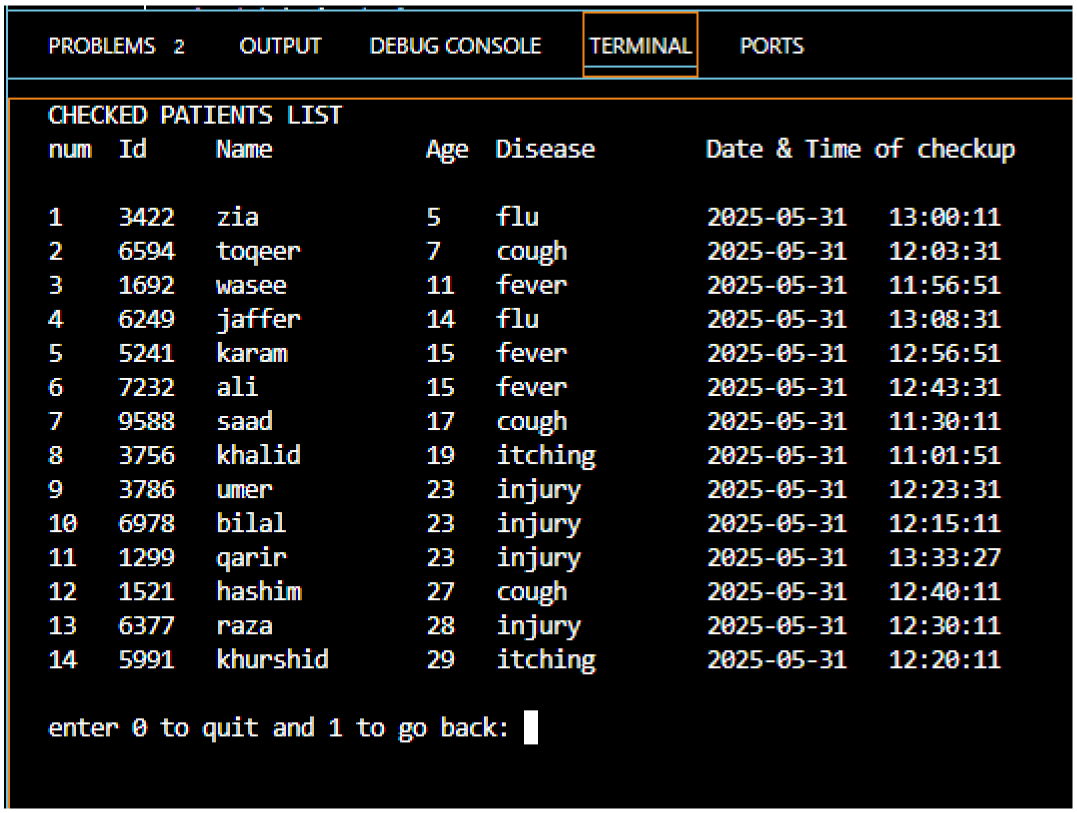
```
SORTING

Enter 1 to sort by age
Enter 2 to sort by name
Enter 3 to sort by time
 your choice :
```

Sort Checked Patients by Age:



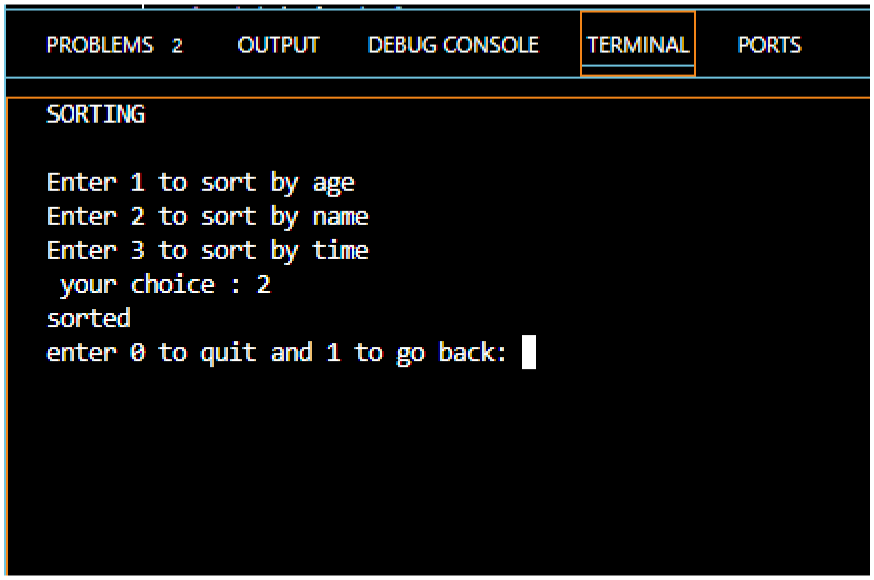
```
SORTING

Enter 1 to sort by age
Enter 2 to sort by name
Enter 3 to sort by time
 your choice : 1
sorted
enter 0 to quit and 1 to go back:
```

Checked Patients List, after Sorting Checked Patients by Age:



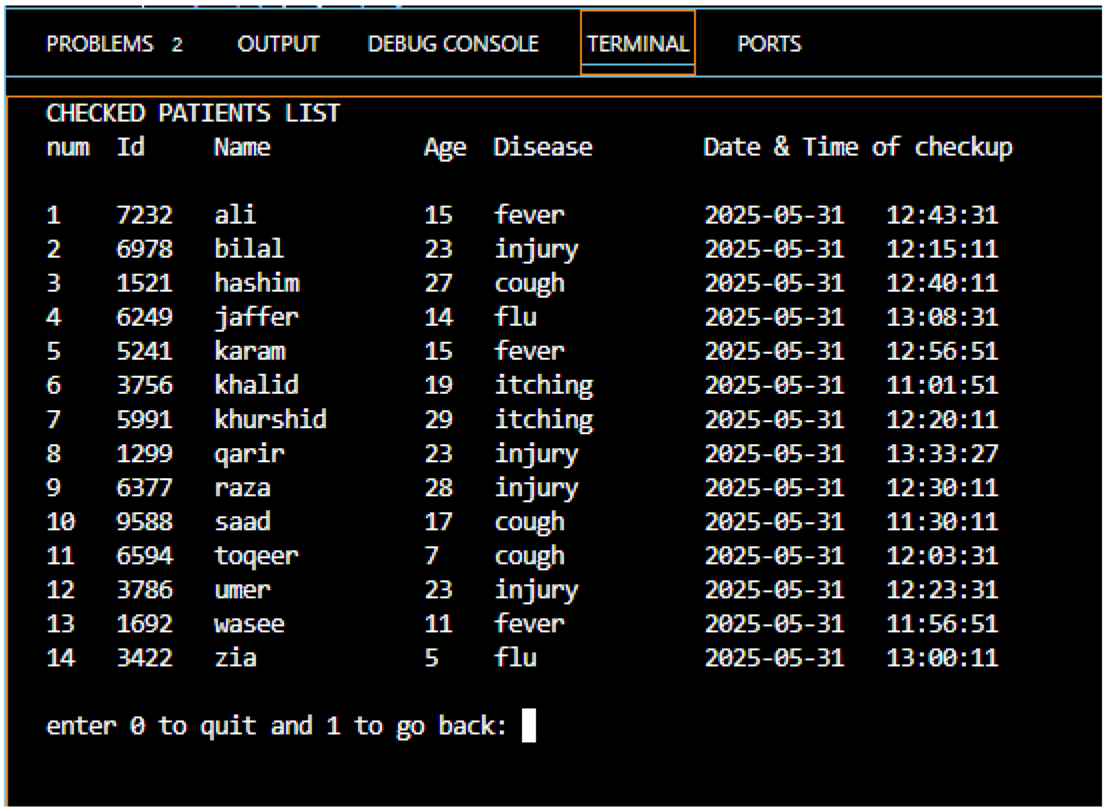
```
CHECKED PATIENTS LIST
num  Id     Name          Age  Disease        Date & Time of checkup

1    3422   zia           5    flu            2025-05-31   13:00:11
2    6594   toqeer        7    cough          2025-05-31   12:03:31
3    1692   wasee         11   fever          2025-05-31   11:56:51
4    6249   jaffer        14   flu            2025-05-31   13:08:31
5    5241   karam         15   fever          2025-05-31   12:56:51
6    7232   ali           15   fever          2025-05-31   12:43:31
7    9588   saad          17   cough          2025-05-31   11:30:11
8    3756   khalid        19   itching        2025-05-31   11:01:51
9    3786   umer          23   injury         2025-05-31   12:23:31
10   6978   bilal         23   injury         2025-05-31   12:15:11
11   1299   qarir         23   injury         2025-05-31   13:33:27
12   1521   hashim        27   cough          2025-05-31   12:40:11
13   6377   raza          28   injury         2025-05-31   12:30:11
14   5991   khurshid      29   itching        2025-05-31   12:20:11

enter 0 to quit and 1 to go back:
```

Sort Checked Patients by Name:



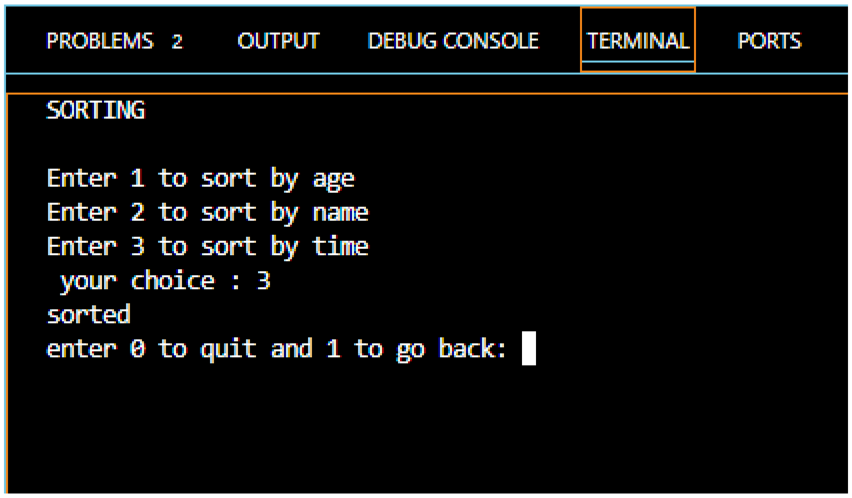
```
SORTING

Enter 1 to sort by age
Enter 2 to sort by name
Enter 3 to sort by time
 your choice : 2
sorted
enter 0 to quit and 1 to go back:
```

Checked Patients List, after Sorting Checked Patients by Name:



```
CHECKED PATIENTS LIST
num  Id     Name          Age  Disease        Date & Time of checkup

1    7232   ali           15   fever          2025-05-31   12:43:31
2    6978   bilal         23   injury         2025-05-31   12:15:11
3    1521   hashim        27   cough          2025-05-31   12:40:11
4    6249   jaffer        14   flu            2025-05-31   13:08:31
5    5241   karam         15   fever          2025-05-31   12:56:51
6    3756   khalid        19   itching        2025-05-31   11:01:51
7    5991   khurshid      29   itching        2025-05-31   12:20:11
8    1299   qarir         23   injury         2025-05-31   13:33:27
9    6377   raza          28   injury         2025-05-31   12:30:11
10   9588   saad          17   cough          2025-05-31   11:30:11
11   6594   toqeer        7    cough          2025-05-31   12:03:31
12   3786   umer          23   injury         2025-05-31   12:23:31
13   1692   wasee         11   fever          2025-05-31   11:56:51
14   3422   zia           5    flu            2025-05-31   13:00:11

enter 0 to quit and 1 to go back:
```

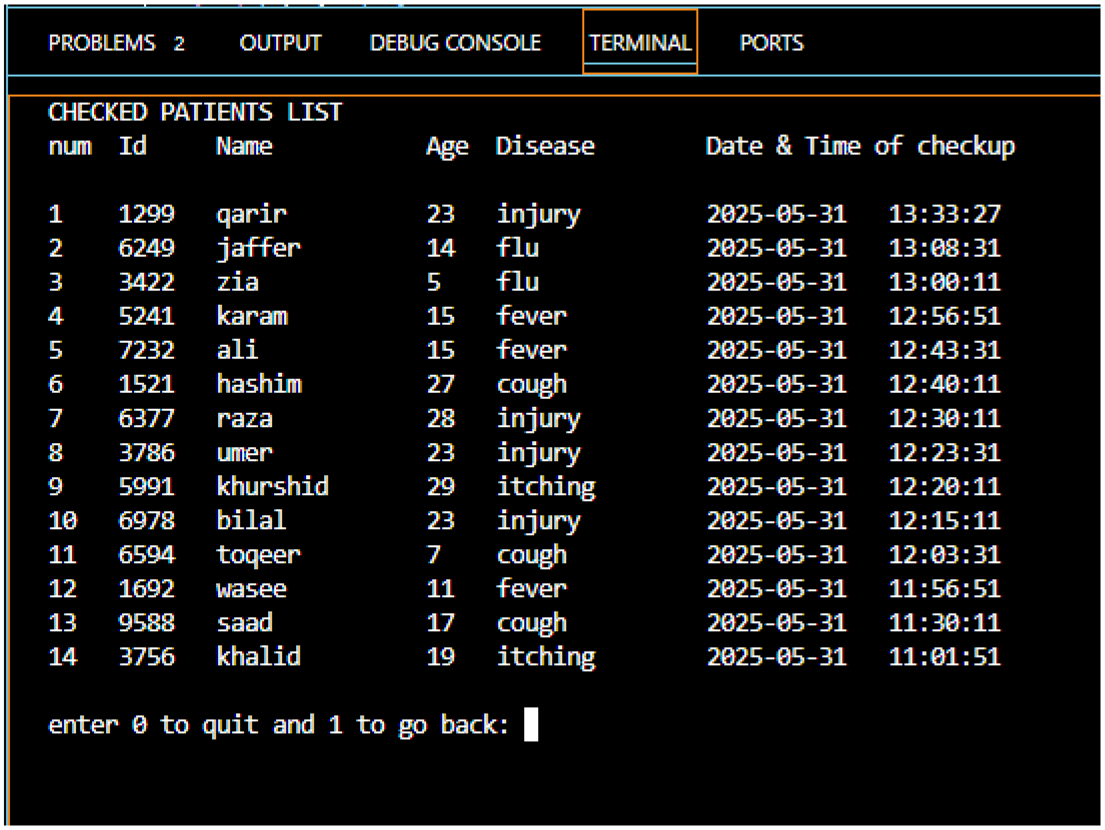
Sort Checked Patients by Checkup Time:



PROBLEMS 2 OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
SORTING

Enter 1 to sort by age
Enter 2 to sort by name
Enter 3 to sort by time
 your choice : 3
sorted
enter 0 to quit and 1 to go back:
```

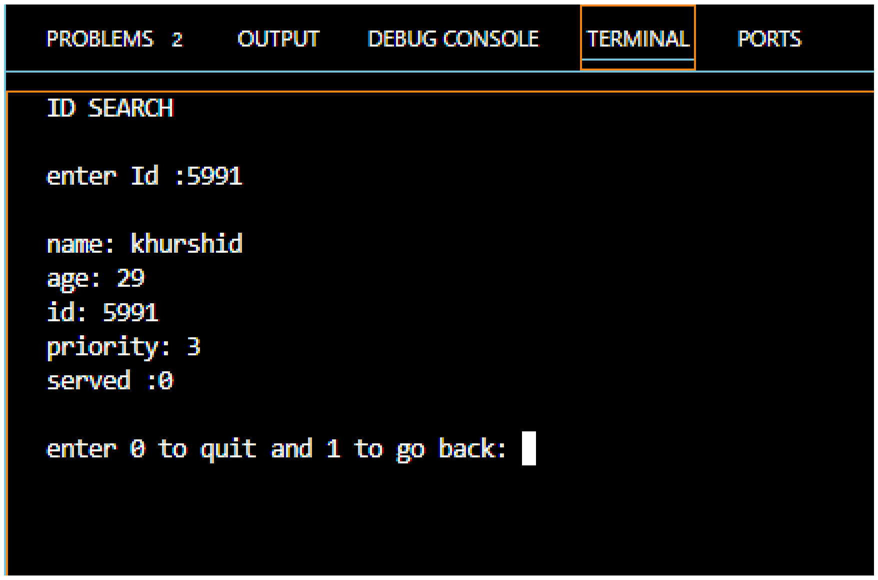
Checked Patients List after Sorting Checked Patients by Checkup Time:



PROBLEMS 2 OUTPUT DEBUG CONSOLE TERMINAL PORTS

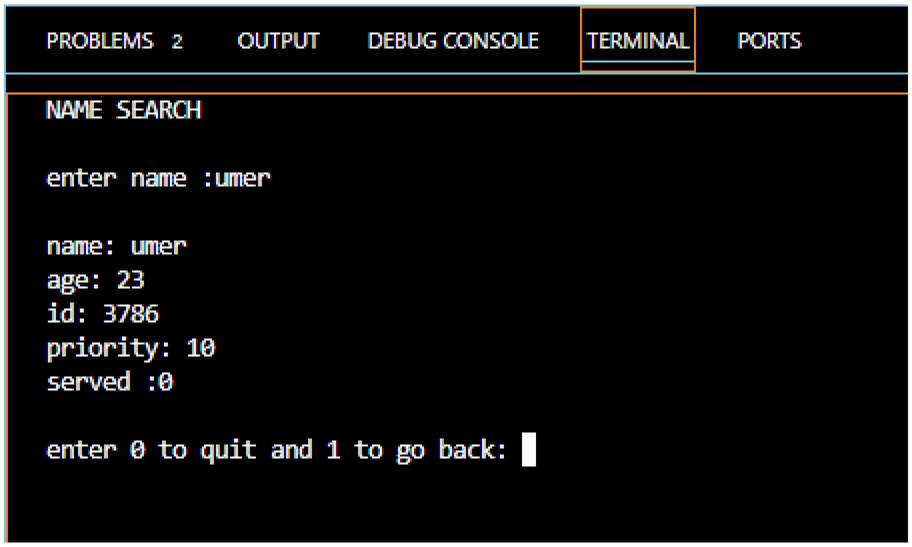
```
CHECKED PATIENTS LIST
num  Id     Name          Age  Disease       Date & Time of checkup

1    1299   qarir         23   injury        2025-05-31   13:33:27
2    6249   jaffer        14   flu           2025-05-31   13:08:31
3    3422   zia           5    flu           2025-05-31   13:00:11
4    5241   karam         15   fever         2025-05-31   12:56:51
5    7232   ali           15   fever         2025-05-31   12:43:31
6    1521   hashim        27   cough         2025-05-31   12:40:11
7    6377   raza          28   injury        2025-05-31   12:30:11
8    3786   umer          23   injury        2025-05-31   12:23:31
9    5991   khurshid      29   itching       2025-05-31   12:20:11
10   6978   bilal         23   injury        2025-05-31   12:15:11
11   6594   toqeer        7    cough         2025-05-31   12:03:31
12   1692   wasee         11   fever         2025-05-31   11:56:51
13   9588   saad          17   cough         2025-05-31   11:30:11
14   3756   khalid        19   itching       2025-05-31   11:01:51

enter 0 to quit and 1 to go back:
```

Search Checked Patients by ID:



```
ID SEARCH

enter Id :5991

name: khurshid
age: 29
id: 5991
priority: 3
served :0

enter 0 to quit and 1 to go back:
```

Search Checked Patients by Name:



```
NAME SEARCH

enter name :umer

name: umer
age: 23
id: 3786
priority: 10
served :0

enter 0 to quit and 1 to go back:
```

Performance Analysis:

Component	Operation	Time Complexity	Remarks
Priority Queue	insert()	O(log n)	Heapify via shiftUp()
	pop()	O(log n)	Heapify via shiftDown()
Hash Table	search()	O(1) best, O(n) worst	Linear probing collisions
	insert()	O(1) best, O(n) worst	Load factor = 35 fixed
Quick Sort	Sort by age	O(n log n) avg	Efficient for large datasets
Selection Sort	Sort by name	$O(n^2)$	Inefficient for large n
Insertion Sort	Sort by Checkup time	$O(n^2)$	Inefficient for large n
Binary Search	Search by name	O(log n)	Requires pre-sorting ($O(n^2)$)
Linear Search	Search by ID (Checked Patients)	O(n)	Inefficient for very large n

Member-wise Contribution:

1. Armughan Naeem (4822-FOC/BSSE/F23)

Core Data Structure Implementation:

⇒ Designed and implemented the priority queue (pQueue class) using a max-heap backed by a vector.

⇒ Developed critical heap operations:

- ➢ shiftUp(): Ensures heap property after insertion (O(log n)).
- ➢ shiftDown(): Maintains heap property after extraction (O(log n)).

⇒ Created queue management functions: insert(), pop(), top(), and showList() for patient display.

System Integration:

⇒ Integrated the priority queue with the patient management workflow (enterQueue()).

⇒ Implemented heap-based prioritization logic to ensure critical patients are served first.

2. Abdullah Shakeel (4793-FOC/BSSE/F23)

Hash Table & ID System

⇒ Make the hash table (hTable class) with linear probing for collision resolution.

⇒ Implemented key hashing operations: insert(), search(), and remove() (O(1) avg).

⇒ Designed the unique patient ID generation system:

- ➢ Auto-generated 4-digit IDs (1000–9999) using rand().
- ➢ Ensured uniqueness via hash table validation (getUniqueId()).

Patient Registration

⇒ Developed patient data capture logic (setData()) with input validation.

3. Usama Javed (4829-FOC/BSSE/F23)

Sorting Algorithms & UI

⇒ Implemented all sorting algorithms for Sorting the patients according to the needs:

- **Quick Sort:** Age-based sorting (quickSort() and qSort()).
- **Selection Sort:** Lexicographical name sorting (selectSort()).
- **Insertion Sort:** Checkup time-based ordering (insertSort()).

⇒ Built the console UI system:

- Designed the interactive menu flow in main().
- Created data display logic for queues/checked patients.

Doctor Operations

- Coded doctor workflows: seeNext(), serveNext(), and queue integration.

4. Syed Hussain Ali (4808-FOC/BSSE/F23)

Searching Algorithms & Debugging

⇒ Implemented search systems:

- **Hash-based search:** Real-time patient lookup in active queue (searchInQ()).
- **Binary Search:** Name-based search in checked list (binarySearch()), requiring pre-sorting.

- **Linear Search:** ID-based scan in checked patients.

Testing & Optimization

⇒ Tested everything and fixed bugs.

⇒ Handle the edge-cases.

Summary:

This project effectively demonstrates the real-world use of data structures and algorithms in managing critical systems like hospital patient queues. It uses object-oriented principles and modular code to ensure maintainability and clarity. Key operations such as insertion, deletion, searching, and sorting are implemented efficiently using standard algorithms.

Future Improvements:

I. File I/O to save patient data between runs.
II. GUI for user-friendly interactions.
III. Time-complexity optimization for sorting large datasets.
IV. Expand system to handle multiple doctors and departments.

Conclusion:

This project demonstrates a practical application of DSA concepts to solve real-world inefficiencies in healthcare management. It enhances hospital efficiency by reducing patient waiting time and supporting medical staff in managing patient flow. By applying priority queues, hash tables, and sorting/searching algorithms, the system ensures critical patients receive timely care while maintaining efficient data tracking. With additional features and UI improvements, it can evolve into a complete hospital management solution.

Links: