RAMAIAH UNIVERSITY OF APPLIED SCIENCES

ASSIGNMENT

Course Code	19CSC213A
Course Name	Programming Paradigms
Programme	B. Tech
Department	Computer Science & Engineering
Faculty	Faculty of Engineering Technology

Name of the Student	SUBHENDU MAJI
Reg. No	18ETCS002121
Semester/Year	4th / 2020
Course Leader/s	Ms. Naveeta

Declaration Sheet				
Student Name	SUBHENDU MAJI			
Reg. No	18ETCS002121			
Programme	B. Tech	Semester/Year	4th / 2020	
Course Code	19CSC213A			
Course Title	Programming Paradigms			
Course Date		To		
Course Leader	Ms. Naveeta			

Declaration

The assignment submitted herewith is a result of my own investigations and that I have conformed to the guidelines against plagiarism as laid out in the Student Handbook. All sections of the text and results, which have been obtained from other sources, are fully referenced. I understand that cheating and plagiarism constitute a breach of University regulations and will be dealt with accordingly.

Signature of the Student		Date	
Submission date stamp (by Examination & Assessment Section)			

Signature of the Course Leader and date	Signature of the Reviewer and date

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Assignment			
Register No.	18ETCS002121	Name of Student	SUBHENDU MAJI

Sections		Marking Scheme	Max Marks	First Examiner Marks	Moderator Marks
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	QA.2	Illustration of how Java programmers rely on the Garbage Collector	01		
	QA.3	Comparison of the manual and the automated approaches	02		
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		Part A Max Marks	**6**		
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		Total Assignment Marks	**20**		

Course Marks Tabulation				
Component- 1(B) Assignment	**First Examiner**	**Remarks**	**Moderator**	**Remarks**
Q1				
Q2				
Marks (out of 20)				

Signature of First Examiner

Signature of Second Examiner

Question No. 1

Solution to Question No. 1:

A1.1 Illustration of how C programmers manually and explicitly free memory

Dynamic memory allocation in C language programming is the process of memory allocation from heap memory at run time. In other word, when memory is allocated from heap during program execution is called dynamic memory allocation.

Also note that, in dynamic memory allocation, memory get allocated from heap and not from stack.

How dynamic memory allocation in C is done?
Dynamic memory allocation in C programming can be done using standard library functions – `malloc()`, `calloc()`, `realloc()` and `free()`. All these library functions are available in "stdlib.h" header file. Hence, we have to include this header in c program.

`malloc ()`, `calloc()` and `realloc ()` – perform memory allocation and free() function perform de-allocation. It is important to note that if we allocate memory dynamically then we must de-allocate it manually / explicitly using `free ()` method. Because, dynamically allocated memory can't be freed automatically like static memory allocation in C.

Function	Purpose	Syntax
malloc	Allocates the memory of requested size and returns the pointer to the first byte of allocated space.	`ptr = (cast_type *) malloc (byte_size);`
calloc	Allocates the space for elements of an array. Initializes the elements to zero and returns a pointer to the memory.	`ptr=(cast_type*)calloc(n, size);`
realloc	It is used to modify the size of previously allocated memory space.	`ptr = realloc (ptr,newsize);`
Free	Frees or empties the previously allocated memory space.	`free(ptr);`

A1.2 Illustration of how Java programmers rely on the Garbage Collector

Garbage collection relieves programmers from the burden of freeing allocated memory. Knowing when to explicitly free allocated memory can be very tricky. Giving this job to the JVM has several advantages.

A garbage collector is responsible for

Allocating memory
Ensuring that any referenced objects remain in memory, and
Recovering memory used by objects that are no longer reachable from references in executing code.

The automatic garbage collector figures out which objects are not reachable and, therefore, eligible for garbage collection. It will certainly go to work if there is a danger of running out of memory. Although the automatic garbage collector tries to run unobtrusively, certain programming practices can nevertheless help in minimizing the overhead associated with garbage collection during program execution. Automatic garbage collection should not be perceived as a license for uninhibited creation of objects and forgetting about them.

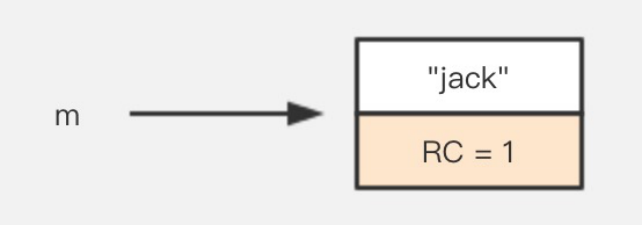
To optimize its memory footprint, a live thread should only retain access to an object as long as the object is needed for its execution. The program can make objects become eligible for garbage collection as early as possible by removing all references to the object when it is no longer needed.

Objects that are created and accessed by local references in a method are eligible for garbage collection when the method terminates, unless reference values to these objects are exported out of the method. This can occur if a reference value is returned from the method, passed as argument to another method that records the reference, or thrown as an exception. However, a method need not always leave objects to be garbage collected after its termination. It can facilitate garbage collection by taking suitable action, for example, by nulling references.

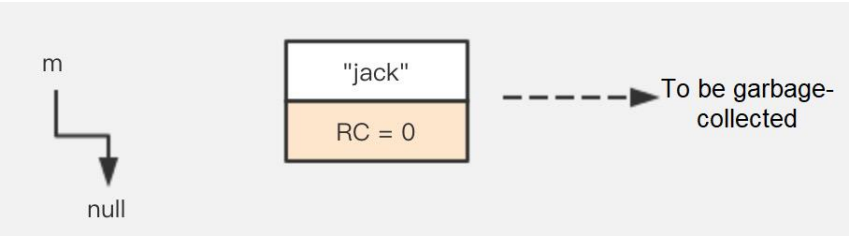
The Reference Counting Algorithm allocates a field in the object header to store the reference count of the object. If this object is referenced by another object, its reference count increments by one. If the reference to this object is deleted, the reference count decrements by one. When the reference count of this object drops to zero, the object will be garbage-collected.

```
String m = new String("jack");
```

let’s create a string in which “jack” is referenced by m.



Then, set m to null. The reference count of “jack” is zero. In the Reference Counting algorithm, the memory for “jack” is to be reclaimed.
m = null;

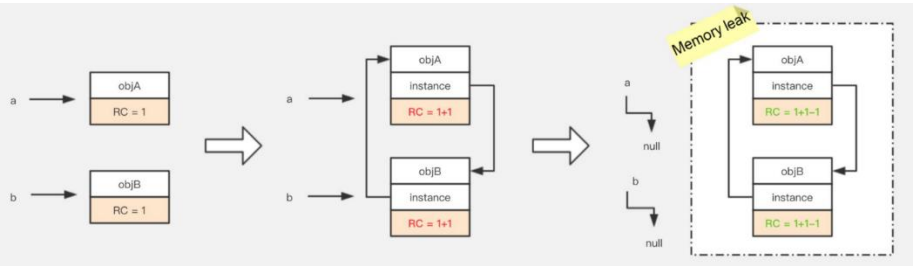


The Reference Counting Algorithm performs GC in the execution of the program. This algorithm does not trigger Stop-The-World events. Stop-The-World means that the execution of the program is suspended for GC till all objects in the heap are processed. Therefore, this algorithm does not strictly follow the Stop-The-World GC mechanism.

It looks pretty applicable to GC. However, we know that GC on the Java virtual machine (JVM) follows the Stop-The-World mechanism. Why did we give up the Reference Counting algorithm? Let’s look at the following example:

```
public class ReferenceCountingGC {    public Object instance;
public ReferenceCountingGC(String name){}
}
public static void testGC()
{
ReferenceCountingGC a = new ReferenceCountingGC("objA");
    ReferenceCountingGC b = new ReferenceCountingGC("objB");
  a.instance = b;
    b.instance = a;
  a = null;
    b = null;
}
```

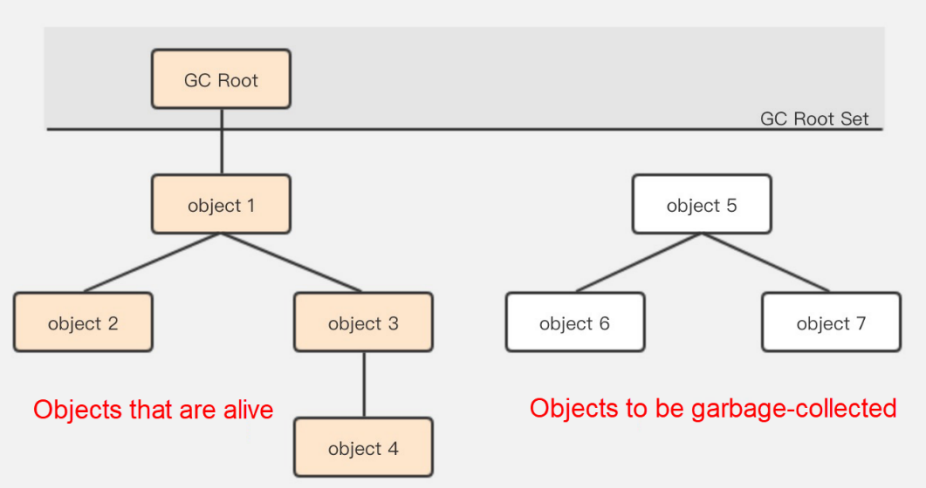
We first define two objects, then make mutual reference to the objects, and lastly set references for each object to null.



We can see that both objects can no longer be accessed. However, they are referenced by each other, and thus their reference count will never be zero. Consequently, the GC collector will never be notified to garbage collect them by using the Reference Counting algorithm.

Reachability Analysis Algorithm

The basic idea of the Reachability Analysis Algorithm is to start from GC roots. GC traverses the whole object graph in the memory, starting from these roots and following references from the roots to other objects. The path is called the reference chain. If an object has no reference chain to the GC roots, that is the object cannot be reached from the GC roots, the object is unavailable.

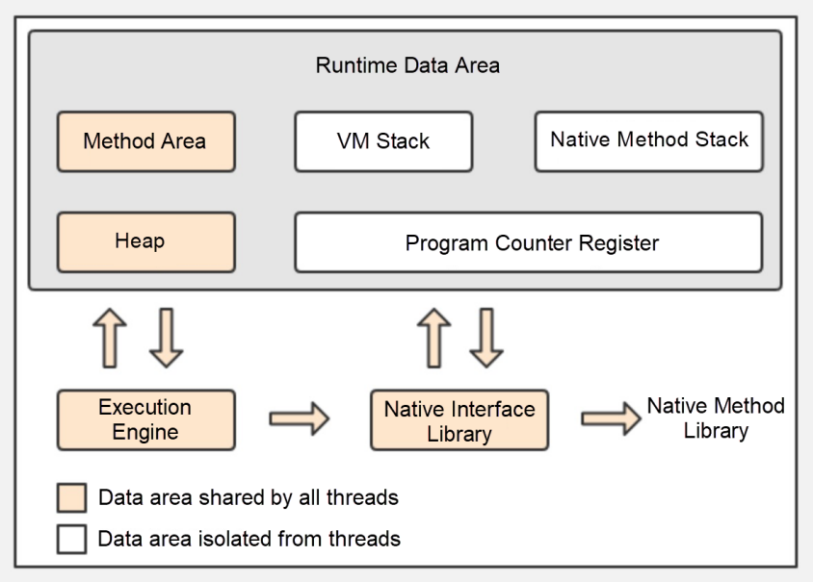


The Reachability Analysis algorithm successfully solves the problem of cyclic references in the Reference Counting algorithm. As long as an object cannot establish a direct or indirect connection with the GC roots, the system determines that the object is to be garbage-collected. Then, another question arises. What are GC roots?

Java Memory Space

In Java, GC roots can be four types of objects:

- Objects referenced in the virtual machine (VM) stack, that is the local variable table in the stack frame
- Objects referenced by class static attributes in the method area
- Objects referenced by constants in the method area
- Objects referenced by JNI (the Native method) in the native method stack



Objects referenced in the VM stack, that is the local variable table in the stack frame

In this case, s is the GC root. When s is set to null, the localParameter object has its reference chain with the GC root broken, and the object will be garbage-collected.

```
public class StackLocalParameter {
    public StackLocalParameter(String name){}
}public static void testGC(){
    StackLocalParameter s = new StackLocalParameter("localParameter");
    s = null;
}
```

Objects referenced by class static attributes in the method area

When s is the GC root and s is set to null, after GC, the properties object to which s points is garbage-collected because it cannot establish a connection with the GC root. As a class static attribute, m is also a GC root. The parameter object is still connected to the GC root, so the parameter object will not be garbage-collected in this case.

```
public class MethodAreaStaicProperties {
    public static MethodAreaStaicProperties m;
    public MethodAreaStaicProperties(String name){}
}public static void testGC(){
    MethodAreaStaicProperties s = new
MethodAreaStaicProperties("properties");
    s.m = new MethodAreaStaicProperties("parameter");
    s = null;
}
```

Objects referenced by constants in the method area

As a constant reference in the method area, m is also the GC root. After s is set to null, the final object will not be garbage-collected though it has no reference chain with the GC root.

```
public class MethodAreaStaicProperties {
    public static final MethodAreaStaicProperties m =
MethodAreaStaicProperties("final");
    public MethodAreaStaicProperties(String name){}
}public static void testGC(){
    MethodAreaStaicProperties s = new
MethodAreaStaicProperties("staticProperties");
    s = null;
}
```

A1.3 Comparison of the manual and the automated approaches

Garbage collection has disadvantages like consuming additional memory (RAM) to run those algorithms and this has a major performance impact. Further, the objects aren't garbage collected at the very instant.

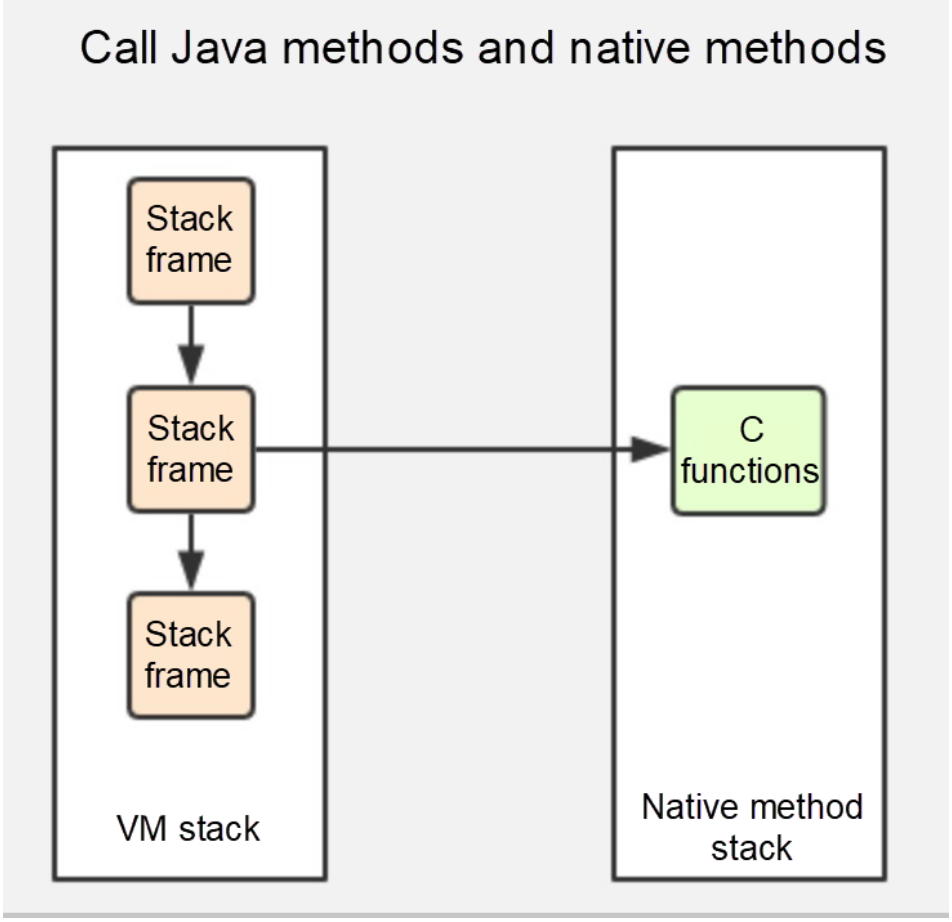
It takes its own time it has a performance impact as well.

A peer-reviewed paper came to the conclusion that GC needs five times the memory to perform as fast as explicit memory management.

If the memory is compromised, it leads to possible stalls in program execution.

Objects referenced in the native method stack.A native interface always uses a native method stack. If the native method interface is implemented by using the C connection model, its native method stack is the C stack.

When a thread calls the Java method, the VM creates a new stack frame and puts it in the Java stack. However, when it calls the native method, the VM keeps the Java stack unchanged and no longer puts new frames in the thread's Java stack. Instead, the VM dynamically connects to and directly calls the specified native method.



A1.4 The stance taken with justification

Garbage collection has disadvantages like consuming additional memory (RAM) to run those algorithms and this has a major performance impact. Further, the objects aren't garbage collected at the very instant.

It takes its own time it has a performance impact as well.

A peer-reviewed paper came to the conclusion that GC needs five times the memory to perform as fast as explicit memory management.

If the memory is compromised, it leads to possible stalls in program execution.

Solution to Question No. 2:

B1.1 Introduction to an Airline reservation system

This is a simple ticket booking system developed in java. This system enables user to book ticket and generate a unique PNR for the ticket while also generating a bill corresponding to the ticket. In the bill it also includes the excess baggage fee as per given in the question.
This system gives users a choice to book ticket, view PNR status, cancel ticket, and see baggage limit. This program does not use any database; hence the data is stored in a List (PNRbook).
While booking a ticket, system asks user to input class from option like Economy, Business, First Class.
The OOP concepts like multiple inheritance, polymorphism has been implemented.

Note: This program has many redundancies. This program is not implemented in an optimized way; hence the program can be further optimized.

B1.2 Design of the Airline reservation system

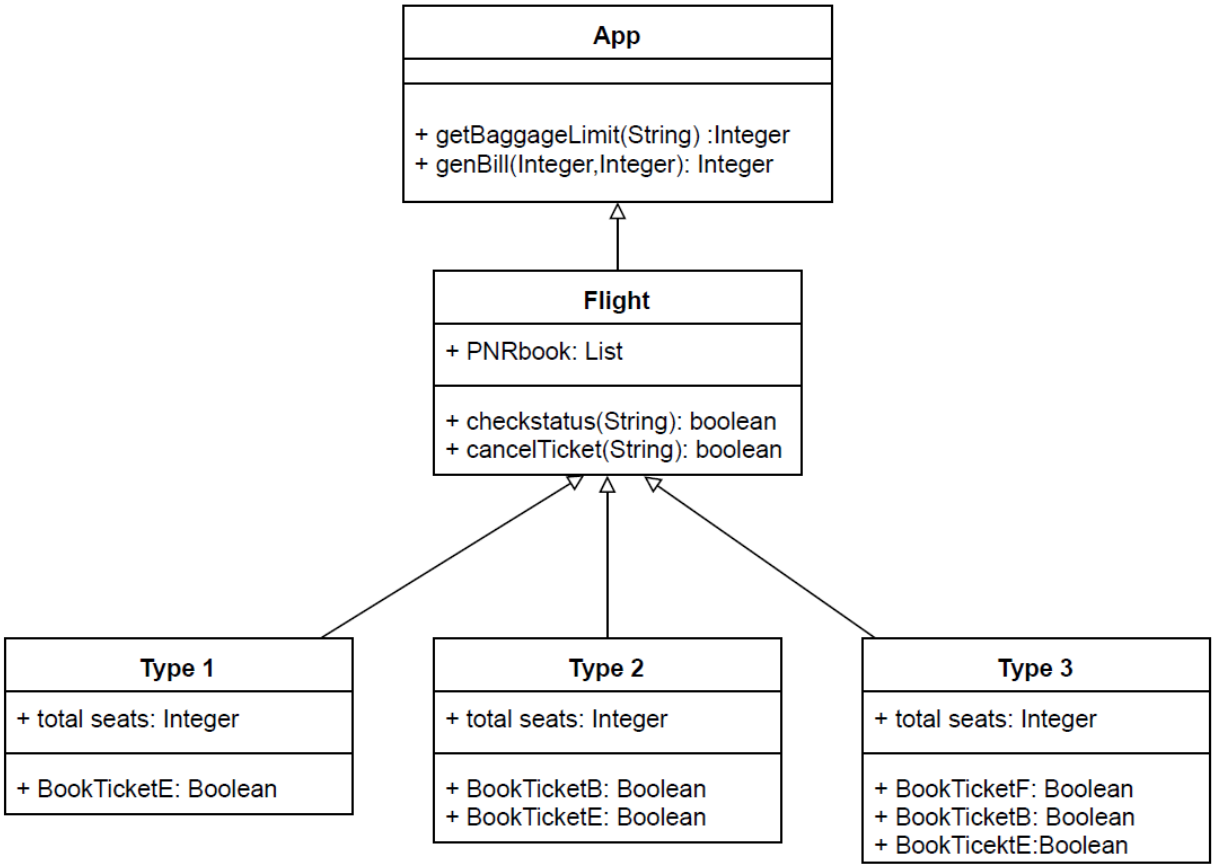


Figure 1 Class of my implementation of Airline Reservation System

B1.3 Implementation of the Airline reservation system

```java
import java.util.*;

public class Flight {

    List<String> PNRbook;

    public Flight(final Integer totalseats) {
        this.PNRbook = new ArrayList<String>(totalseats);
    }

    public boolean checkStatus(final String PNR) {
        if (!PNRbook.contains(PNR)) {
            System.out.println("PNR not found !!");
            return false;
        }

        if (PNR.contains("ECO")) {
            System.out.println("---CLASS: ECONOMY");
        } else if (PNR.contains("BUS")) {
            System.out.println("---CLASS: BUISNESS");

        } else if (PNR.contains("FIR")) {
            System.out.println("---CLASS: FIRST CLASS");

        }

        if (PNR.contains("1")) {
            System.out.println("---FLIGHT: TYPE 1");
        } else if (PNR.contains("2")) {
            System.out.println("---FLIGHT: TYPE 2");

        } else if (PNR.contains("3")) {
            System.out.println("---FLIGHT: TYPE 3");

        }

        final Integer idx = this.PNRbook.indexOf(PNR) + 1;

        System.out.println("---SEAT " + idx);

        return true;
    }

    public boolean cancelTicket(final String PNR) {

        this.PNRbook.set(PNRbook.indexOf(PNR), null);
        return true;
    }

}

```

Figure 2 Flight Class

```java

public class Type1 extends Flight {

    int totalSeats = 60;

    public Type1(Integer totalSeats) {
        // call the parent constructor
        super(totalSeats);
    }

    public boolean BookTicketE() {

        final int EseatCount = 60;

        if (PNRbook.size() != EseatCount) {

            final String GenPNR = "ECOFLA1" + (char) (PNRbook.size() + 65);
            this.PNRbook.add(PNRbook.size(), GenPNR);
            System.out.println("Ticket Succesfully Booked. PNR :" + GenPNR);
            return true;
        } else {
            return false;
        }

    }

}
```

Figure 3 Type 1 Class which extends Flight Class

```java

public class Type2 extends Flight {
    int totalSeats = 60;

    public Type2(Integer totalSeats) {
        // call the parent constructor
        super(totalSeats);
    }

    public boolean BookTicketE() {

        final int EseatCount = 40;

        if (PNRbook.size() != EseatCount) {

            final String GenPNR = "ECOFLA2" + (char) (PNRbook.size() + 65);
            this.PNRbook.add(PNRbook.size(), GenPNR);
            System.out.println("Ticket Succesfully Booked. PNR : " + GenPNR);
            return true;
        } else {
            return false;
        }

    }

    public boolean BookTicketB() {
        final int BseatCount = 10;

        if (PNRbook.size() != BseatCount) {

            final String GenPNR = "BUSFLA2" + (char) (PNRbook.size() + 65);
            this.PNRbook.add(PNRbook.size(), GenPNR);
            System.out.println("Ticket Succesfully Booked. PNR : " + GenPNR);
            return true;
        } else {
            return false;
        }

    }
}
```

Figure 4 Type 2 Class which extends Flight Class

```java

public class Type3 extends Flight {
    int totalSeats = 60;

    public Type3(Integer totalSeats) {
        // call the parent constructor
        super(totalSeats);
    }

    public boolean BookTicketF() {
        final int FseatCount = 10;

        if (PNRbook.size() != FseatCount) {

            final String GenPNR = "FIRFLA3" + (char) (PNRbook.size() + 65);
            this.PNRbook.add(PNRbook.size(), GenPNR);
            System.out.println("Ticket Succesfully Booked. PNR : " + GenPNR);
            return true;
        } else {
            return false;
        }

    }

    public boolean BookTicketE() {
        final int EseatCount = 40;

        if (PNRbook.size() != EseatCount) {

            final String GenPNR = "ECOFLA3" + (char) (PNRbook.size() + 65);
            this.PNRbook.add(PNRbook.size(), GenPNR);
            System.out.println("Ticket Succesfully Booked. PNR : " + GenPNR);
            return true;
        } else {
            return false;
        }

    };

    public boolean BookTicketB() {
        final int BseatCount = 10;

        if (PNRbook.size() != BseatCount) {

            final String GenPNR = "BUSFLA3" + (char) (PNRbook.size() + 65);
            this.PNRbook.add(PNRbook.size(), GenPNR);
            System.out.println("Ticket Succesfully Booked. PNR : =" + GenPNR);
            return true;
        } else {
            return false;
        }

    }

}
```

Figure 5 Type 3 Class which extends Flight Class

```java

import java.util.*;

public class App {

    public static Integer getBaggageLimit(final String PNR) {
        if (PNR.contains("ECO")) {
            return 20;
        } else if (PNR.contains("BUS")) {
            return 35;
        } else if (PNR.contains("FIR")) {
            return 40;
        }
        return null;
    }

    public static Integer genBill(Integer Baggage, Integer Limit) {
        if (Baggage <= Limit) {
            return 0;
        } else if (Baggage >= Limit) {
            return (Baggage - Limit);
        } else {
            return null;
        }
    }

    public static void main(final String[] args) {

        final Type1 Eticket = new Type1(60);
        final Type2 Bticket = new Type2(60);
        final Type3 Fticket = new Type3(60);
        final Scanner sc = new Scanner(System.in);

        while (true) {
            int billPrice = 0;
            System.out.println("::: MENU :::");

            System.out.println("01: Book Ticket");
            System.out.println("02: PNR status");
            System.out.println("03: Cancel booked Ticket");
            System.out.println("04: Get Baggage Limit using PNR");
            System.out.println("05: Exit");
            System.out.print("Enter Choice :: ");

            final int choice = sc.nextInt();

            try {
                switch (choice) {

                    case 1: {
                        System.out.println("------We have : ");
                        System.out.println("------01 : Economy class (Base Fare : Rs.5,000)");
                        System.out.println("------02 : Business class (Base Fare : Rs.7,000)");
                        System.out.println("------03 : First Class (Base Fare : Rs.10,000)");
                        System.out.print("--------------Enter type of flight : ");

                        final int classChoice = sc.nextInt();
                        try {
                            switch (classChoice) {
                                case 1: {
                                    billPrice = 5000;

                                    System.out.println("Enter Baggage (in Kgs): ");
                                    final int Bag = sc.nextInt();
                                    if (Bag > 20) {
                                        System.out.println("Baggage more than 20 Kgs not Allowed");
                                    } else {
                                        billPrice += genBill(Bag, 15) * 2000;
                                    }

                                    if (Eticket.BookTicketE()) {
                                    } else if (Bticket.BookTicketE()) {
                                    } else if (Fticket.BookTicketE()) {
                                    } else
                                        System.out.println("No seats Available");

                                    System.out.println("Ticket booked Succesfully !! BILL = Rs." + billPrice);
                                    break;
                                }

                                case 2: {
                                    billPrice = 7000;

                                    System.out.println("Enter Baggage (in Kgs): ");
                                    final int Bag = sc.nextInt();
                                    if (Bag > 35) {
                                        System.out.println("Baggage more than 35 Kgs not Allowed");
                                    } else {
                                        billPrice += genBill(Bag, 25) * 3000;
                                    }

                                    if (Bticket.BookTicketB()) {
                                    } else if (Fticket.BookTicketB()) {
                                    } else
                                        System.out.println("No seats Available");

                                    System.out.println("Ticket booked Succesfully !! BILL = Rs." + billPrice);

                                    break;
                                }
```

```
                            case 3: {
                                    billPrice = 10000;
                                    System.out.println("Enter Baggage (in Kgs): ");
                                    final int Bag = sc.nextInt();
                                    if (Bag > 40) {
                                        System.out.println("Baggage more than 40 Kgs not Allowed");
                                    } else {
                                        billPrice += genBill(Bag, 30) * 4000;
                                    }

                                    if (Fticket.BookTicketF()) {
                                    } else
                                        System.out.println("No seats Available");
                                    System.out.println("Ticket booked Succesfully !! BILL = Rs." + billPrice);

                                    break;
                                }
                                default: {
                                    throw new Exception("Invalid input !!!");
                                }

                            }
                        } catch (final Exception e) {
                            System.out.println("Invalid Input !! Error :" + e);
                        }
                        break;
                    }
                    case 2: {

                        try {
                            String PNRent;

                            System.out.println("Enter PNR :");

                            PNRent = sc.next();

                            System.out.println("Status of your ticket :: ");

                            if (PNRent.contains("FLA1")) {
                                if (Eticket.checkStatus(PNRent)) {
                                    System.out.print("confirmed");
                                }
                            } else if (PNRent.contains("FLA2")) {
                                if (Bticket.checkStatus(PNRent)) {
                                    System.out.print("ticket is confirmed");
                                }

                            } else if (PNRent.contains("FLA3")) {
                                if (Fticket.checkStatus(PNRent)) {
                                    System.out.print("Ticket is confirmed");
                                } else {
                                    System.out.print("PNR Not found");
                                }

                            } else {
                                throw new Exception("Invalid Input !!!");
                            }

                        } catch (final Exception e) {
                            System.out.println("Invalid input !!" + e);
                        }
                        break;
                    }
                    case 3: {

                        System.out.println("Enter PNR : ");

                        final String PNRent = sc.next();
                        try {
                            if (PNRent.contains("FLA1")) {
                                if (Eticket.cancelTicket(PNRent)) {
                                    System.out.println("Your ticket has been cancelled");
                                }
                                ;
                            } else if (PNRent.contains("FLA2")) {
                                if (Bticket.cancelTicket(PNRent)) {
                                    System.out.println("Your ticket has been cancelled");
                                }
                                ;
                            } else if (PNRent.contains("FLA3")) {
                                if (Fticket.cancelTicket(PNRent)) {
                                    System.out.println("Your ticket has been cancelled");
                                }
                                ;
                            } else {
                                throw new Exception("Invalid Input");
                            }

                        } catch (final Exception e) {
                            System.out.println("Invalid Input");
                        }
                        break;
                    }
                    case 4: {
                        System.out.println("Enter PNR : ");

                        final String PNR = sc.next();
                        System.out.println("Max Baggage Limit :" + getBaggageLimit(PNR));

                        break;
                    }
                    case 5: {
                        break;
                    }
                    default: {
                        throw new Exception("Invalid input !!");
                    }
                }

            } catch (final Exception e) {
                System.out.println(e);
            }
        }
    }

}
```

Figure 6 App Class - Driver Class

Output Screenshot:

```
PS D:\RUAS-sem-04\PP\assignment\airline-reservation-system> cd "d:\RUAS-sem-04\PP\assignment
m\" ; if ($?) { javac App.java } ; if ($?) { java App }
::: MENU :::
01: Book Ticket
02: PNR status
03: Cancel booked Ticket
04: Get Baggage Limit using PNR
05: Exit
Enter Choice :: 
```

Figure 7 Menu

```
PS D:\RUAS-sem-04\PP\assignment\airline-reservation-system>
m\" ; if ($?) { javac App.java } ; if ($?) { java App }
::: MENU :::
01: Book Ticket
02: PNR status
03: Cancel booked Ticket
04: Get Baggage Limit using PNR
05: Exit
Enter Choice :: 1
------We have :
------01 : Economy class (Base Fare : Rs.5,000)
------02 : Business class (Base Fare : Rs.7,000)
------03 : First Class (Base Fare : Rs.10,000)
--------------Enter type of flight : 2
Enter Baggage (in Kgs):
27
Ticket Succesfully Booked. PNR : BUSFLA2A
Ticket booked Succesfully !! BILL = Rs.13000
```

Figure 8 Booking Ticket for Business Class

```
::: MENU :::
01: Book Ticket
02: PNR status
03: Cancel booked Ticket
04: Get Baggage Limit using PNR
05: Exit
Enter Choice :: 2
Enter PNR :
BUSFLA2A
Status of your ticket ::
---CLASS: BUISNESS
---FLIGHT: TYPE 2
---SEAT 1
ticket is confirmed::: MENU :::
```

Figure 9 Checking status of PNR

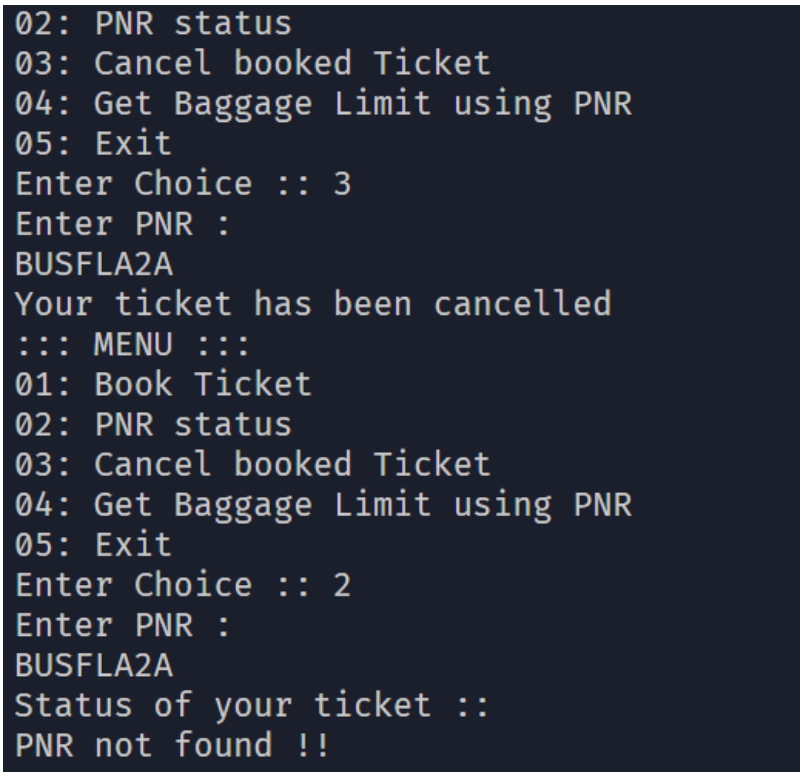


Figure 10 Cancelling ticket – deleting PNR from List

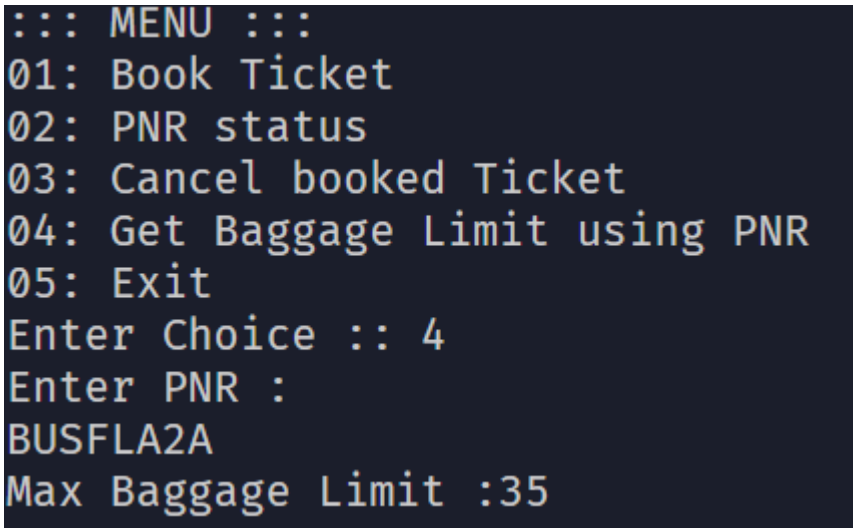


Figure 11 getting Baggage limit

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The source code of the above implemented of Airline Reservation System can be found at :

https://github.com/subhendu17620/RUAS-sem-04/tree/master/PP/assignment/airline-reservation-system