PROJECT DOCUMENTATION

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DEPARTMENT OF SOFTWARE ENGINEERING

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PROGRAMMING AND DATA STRUCTURES MINI PROJECT

AIR TRAFFIC CONTROL SYSYTEM

AIM

To control the air traffic based on the landing and takeoff details of flights and automatic allotment of runway, gate and hangar in the airport according to the priority of flights using priority queue implemented with binary heap

PROBLEM STATEMENT

- Identify the order in which the flights have to be landed or taken off
- Prioirity of landing flights have to based on multiple ascpects like distance from the runway, fuel left and time halt in fixed pattern in air
- Priority of takeoff flights must be based on the departure time
- Allot runway, gate and hangar for every flight according to the order identified previously

KEY FUNCTIONS

- LANDING

1. Get the landing flight details
2. Display the landing flight details
3. Writing the details into a file named ‘land.txt’
4. Reading the file ‘land.txt’
5. Display the priority chart of landing flights
6. Priority calculation and displaying flight details with its corressponding priority
7. Displaying the landing flight details in decreasing order based on its priority
8. Writing the ordered flight details into a file named ‘landpriority.txt’
9. Runway, gate and hangar allotment of landing flights

➢ TAKEOFF

1. Get the takeoff flight details
2. Display the takeoff flight details
3. Writing the details into a file named ‘depart.txt’
4. Reading the file ‘depart.txt’
5. Priority calculation and displaying flight details with its corressponding priority
6. Displaying the takeoff flight details in decreasing order based on its priority
7. Writing the ordered flight details into a file named ‘departpriority.txt’
8. Runway, gate and hangar allotment of takeoff flights

EXPLANATION ON KEY FUNCTIONS

➢ LANDING

1. Get the takeoff flight details

- ✓ Get the flight details like flight id, flight name, distance from the runway, fuel left in the flight and halt time that the flight remains in same pattern
- ✓ Store all these details into a structure named ‘land’ using dynamic memory allocation in order to save unused space
- ✓ Get as many number of flights as the user wishes and reallocate memory of structure accordingly

2. Display the landing flight details

- ✓ Display the landing flight details in a structured manner by retrieving the flight details from the structure ‘land’

3. Writing the details into a file named ‘land.txt’

- ✓ Open a file ‘land.txt’ in write mode in order to write the landing flight details

- ✓ Store the column headings into the file so that the information can be made more understandable
- ✓ Retrieve the landing flight details from the structure ‘land’ and store them into the file created
- ✓ Close the specific file
- ✓ Hence the landing flight details were successfully written into the file and can be referred anytime in the future

4. Reading the file ‘land.txt’

- ✓ Open the file ‘land.txt’ in read mode in order to read the same file from the program
- ✓ Retrieve the details that are stored in the file and display the landing flight details in a structured format
- ✓ Close the specific file
- ✓ Hence, the landing flight details were read successfully from the file and displayed

5. Display the priority chart of landing flights

- ✓ Priority chart is based on the importance given to various aspects of landing flights like distance from the runway, fuel left in the flightt and the halt time that the flight flies in air in the same pattern

Parameters	low		medium		high	
Distance from the runway (in km)	(0-5)	20	(5-8)	10	(8-20)	5
Fuel left (in ltr)	(0-40)	30	(40-80)	20	(80-150)	10
Time halt (in min)	(20-50)	10	(10-20)	5	(0-10)	2

6. Priority calculation and displaying flight details with its corressponding priority

- ✓ Priority is calculated based on the priority chart given above
- ✓ Once the priority is calculated, the flight details are dislplayed along with the calculated priority values

- ✓ Display the flight details in a formatted table

7. Displaying the landing flight details in decreasing order based on its priority

- ✓ Priority values and corressponding flight ids are sent into a priority queue implemented using a binary heap
- ✓ Once these values are inserted into the priority queue maximium value in priority queue is extracted using a function and that value is returned
- ✓ Hence, the landing flight details and their corressponding priority values are displayed in a decreasing order of their priority

8. Writing the ordered flight details into a file named ‘landpriority.txt’

- ✓ Open a file named ‘landpriority.txt’ in write mode
- ✓ Store the column headings into the file so that the information can be made more understandable
- ✓ Ordered landing flight details are written into the file ‘landpriority.txt’
- ✓ Close the file after writing the details
- ✓ Now, the order in which flights have to be landed is found

9. Runway, gate and hangar allotment of landing flights

- ✓ The flight ids are retrieved from the structure as per the order specified by the priority queue and are stored in an array
- ✓ Now implement multiple for loops with multiple if conditions to allot the runway, gate and hangar for all the landing flights
- ✓ First check if runways are free then we can land the flight.
- ✓ If not then check if gates are free so that flights in runway can be moved to gates.
- ✓ If gates are filled then move the flights from gates to hangar so that gates are freed and flights from runway can be moved to gates and flights waiting to land can use the runways
- ✓ In this means, the landing flights are alotted runways, gates and hangar according to their priority

➢ TAKEOFF

1. Get the takeoff flight details

- ✓ Get the flight details like flight id, flight name, departure time and direction of takeoff
- ✓ Store all these details into a structure named ‘depart’ using dynamic memory allocation in order to save unused space
- ✓ Get as many number of flights as the user wishes and reallocate memory of structure accordingly

2. Display the takeoff flight details

- ✓ Display the takeoff flight details in a structured manner by retrieving the flight details from the structure ‘depart’

3. Writing the details into a file named ‘depart.txt’

- ✓ Open a file ‘depart.txt’ in write mode in order to write the taking off flight details
- ✓ Store the column headings into the file so that the information can be made more understandable
- ✓ Retrieve the departing flight details from the structure ‘depart’ and store them into the file created
- ✓ Close the specific file
- ✓ Hence the departing flight details were successfully written into the file and can be referred anytime in the future

4. Reading the file ‘depart.txt’

- ✓ Open the file ‘depart.txt’ in read mode in order to read the same file from the program
- ✓ Retrieve the details that are stored in the file and display the departing flight details in a structured format
- ✓ Close the specific file

- ✓ Hence, the departing flight details were read successfully from the file and displayed

5. Priority calculation and displaying flight details with its corressponding priority

- ✓ Priority is calculated based on the departure time
- ✓ Once the priority is calculated, the flight details are dislplayed along with the calculated priority values
- ✓ Display the flight details in a structured table format

6. Displaying the landing flight details in decreasing order based on its priority

- ✓ Priority values and corressponding flight ids are sent into a priority queue implemented using a binary heap
- ✓ Once these values are inserted into the priority queue maximium value in priority queue is extracted using a function and that value is returned
- ✓ Priority queue returns the flights with decreasing order of time
- ✓ So the array has to be reversed to get the flight details that has to takeoff early
- ✓ Now the list is in increasing order of departure time
- ✓ Hence, the landing flight details and their corressponding priority values are displayed in a increasing order of their departure time

7. Writing the ordered flight details into a file named ‘departpriority.txt’

- ✓ Open a file named ‘departpriority.txt’ in write mode
- ✓ Store the column headings into the file so that the information can be made more understandable
- ✓ Ordered takeoff flight details are written into the file ‘departpriority.txt’
- ✓ Close the file after writing the details
- ✓ Now, the order in which flights have to be taken off is found

8.Runway, gate allotment and order of take off of landing flights

- ✓ The flight ids are retrieved from the structure as per the order specified by the priority queue and are stored in an array
- ✓ Now implement multiple for loops with multiple if conditions to allot the runway, gate for all the departing flights
- ✓ First check if gates are free then we can move the flight from hangar to gate.
- ✓ If not then check if runways are free so that flights in gate can be moved to runway.
- ✓ If runways are filled then move the flights from runway to takeoff immediately so that runways are freed and flights from gates can be moved to runways and flights waiting in hangar can use the gates
- ✓ In this means, the departing flights are alotted runways and gates according to their priority

DATA STRUCTURES USED

- ➢ Priority queue is used to order the landing flights based on the priority calculated using prioirity chart. Here priority queue is implemented using a binary heap.

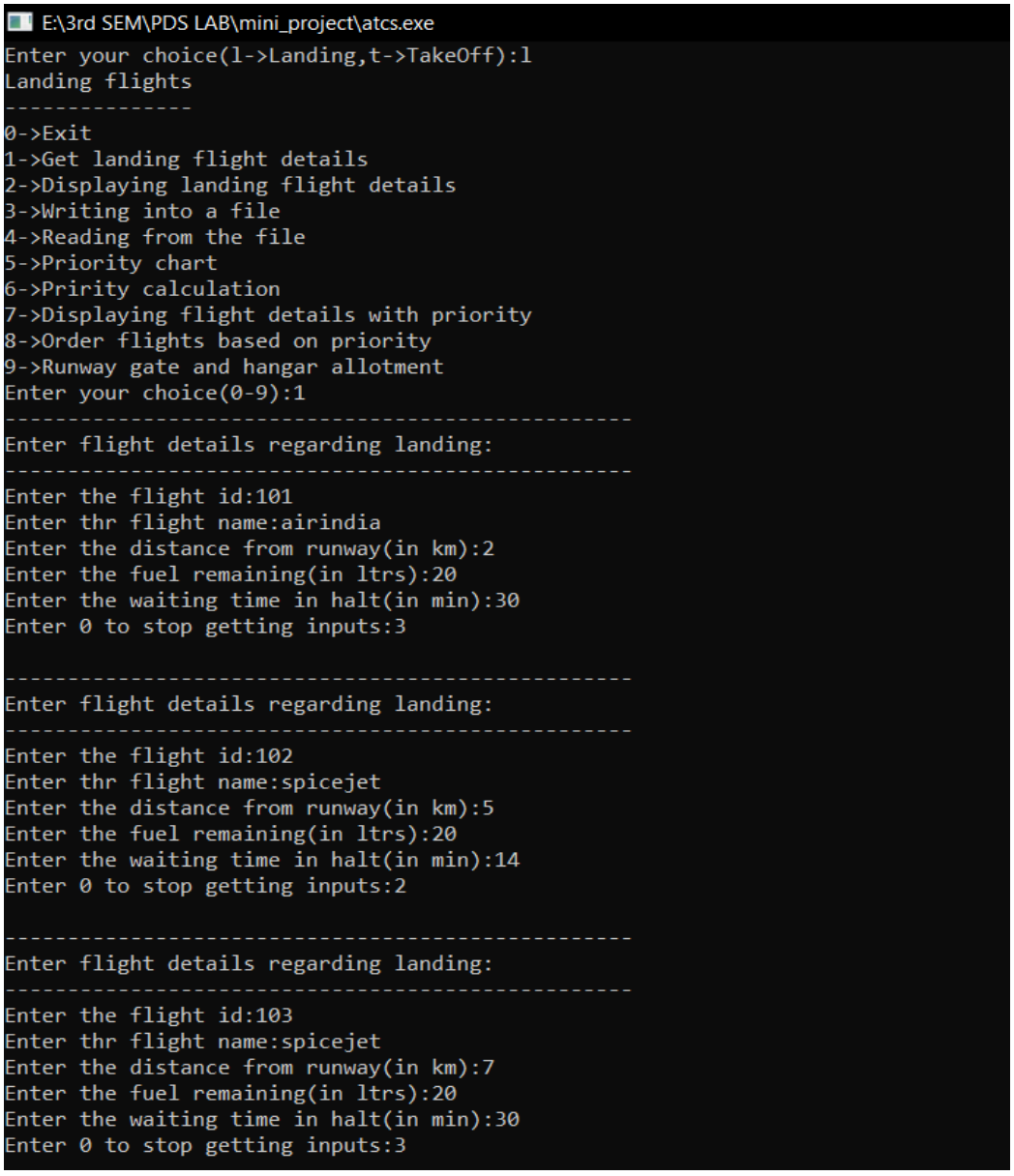
- ➢ Priority queue is also used to order the takeoff flights based on the departure time.Here too, the priority queue is implented using a binary heap.

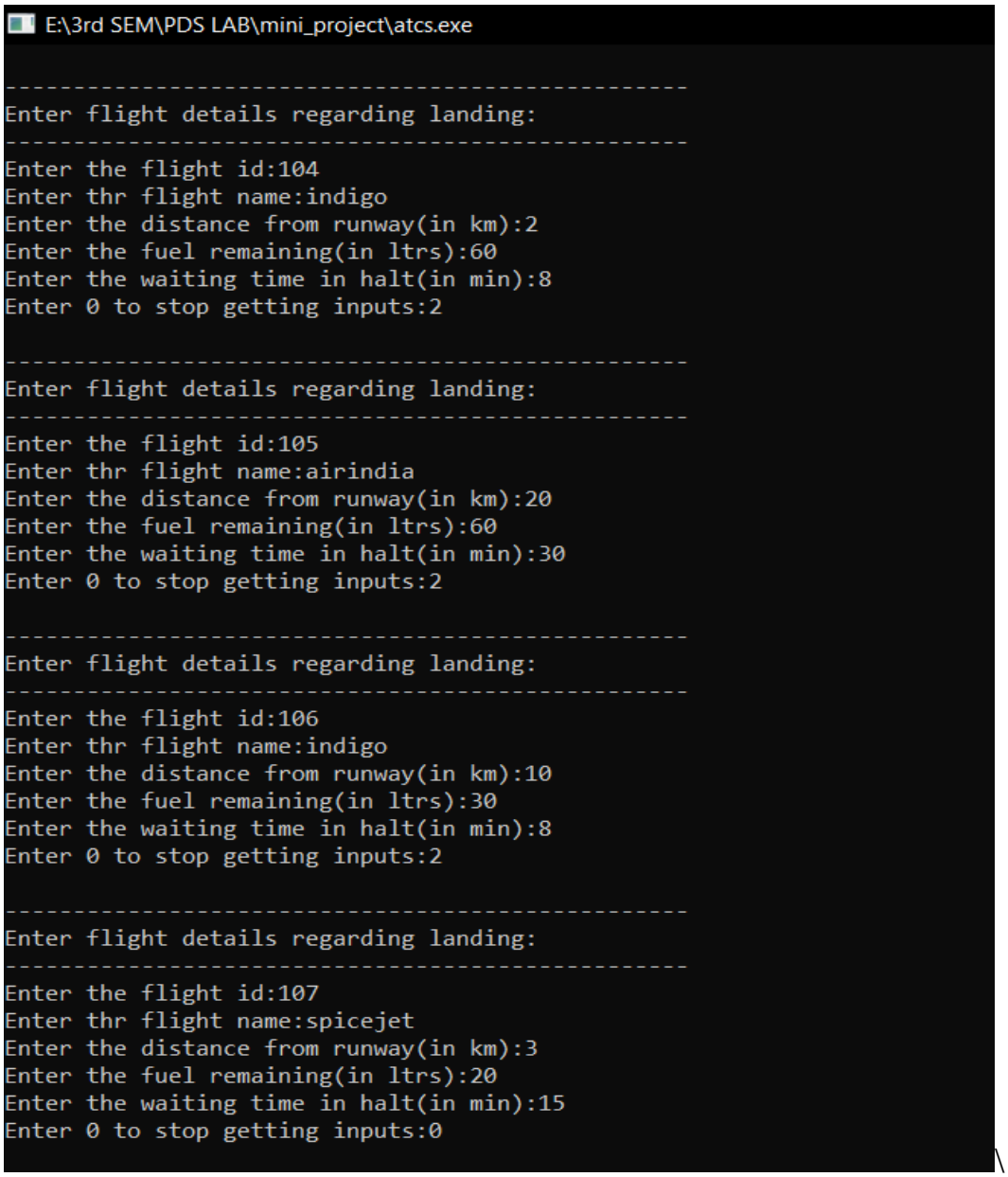
- ➢ Implementation of priority queue using binary heap is more efficient than array and linked list implementation of priority queue as time complexity of insertion and deletion in priority queue using linked list is O(n) while the same using binary heap is O(log n)

OUTPUT SCREENSHOTS

- LANDING

1. Get the landing flight details

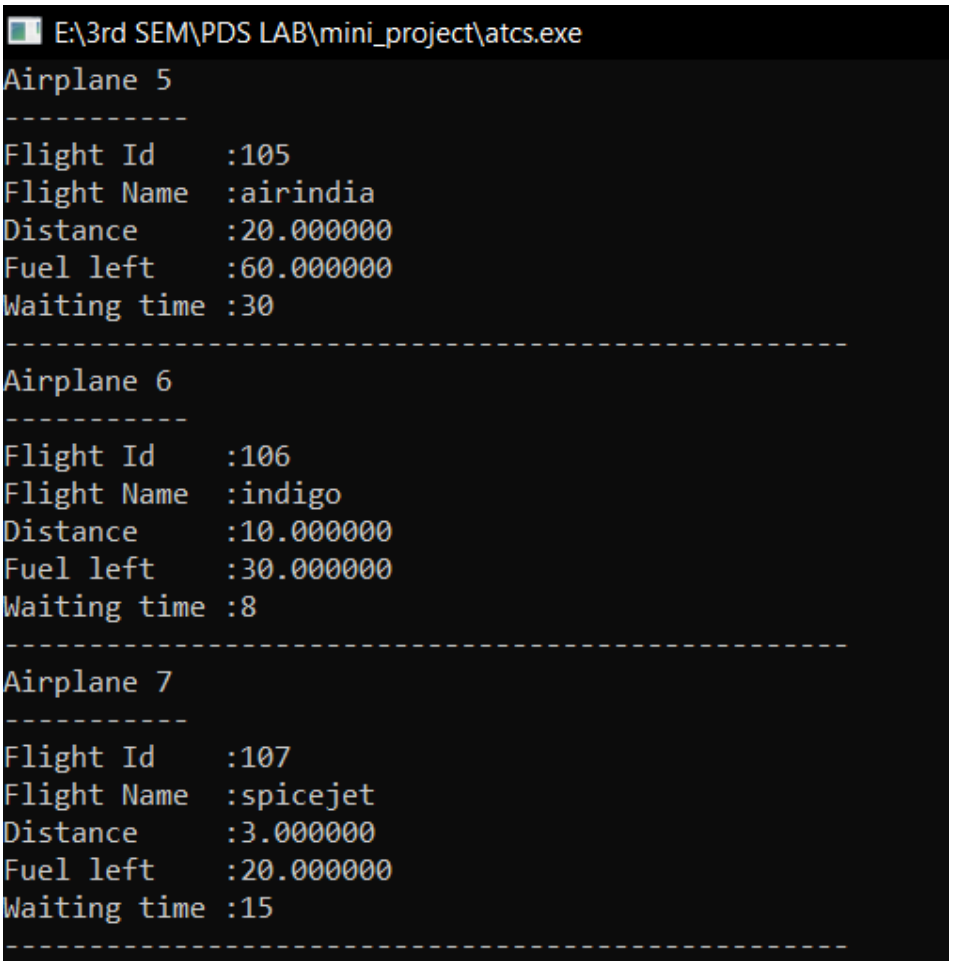



E:\3rd SEM\PDS LAB\mini_project\atcs.exe
Enter flight details regarding landing:
Enter the flight id:104
Enter thr flight name:indigo
Enter the distance from runway(in km):2
Enter the fuel remaining(in ltrs):60
Enter the waiting time in halt(in min):8
Enter 0 to stop getting inputs:2
Enter flight details regarding landing:
Enter the flight id:105
Enter thr flight name:airindia
Enter the distance from runway(in km):20
Enter the fuel remaining(in ltrs):60
Enter the waiting time in halt(in min):30
Enter 0 to stop getting inputs:2
Enter flight details regarding landing:
Enter the flight id:106
Enter thr flight name:indigo
Enter the distance from runway(in km):10
Enter the fuel remaining(in ltrs):30
Enter the waiting time in halt(in min):8
Enter 0 to stop getting inputs:2
Enter flight details regarding landing:
Enter the flight id:107
Enter thr flight name:spicejet
Enter the distance from runway(in km):3
Enter the fuel remaining(in ltrs):20
Enter the waiting time in halt(in min):15
Enter 0 to stop getting inputs:0

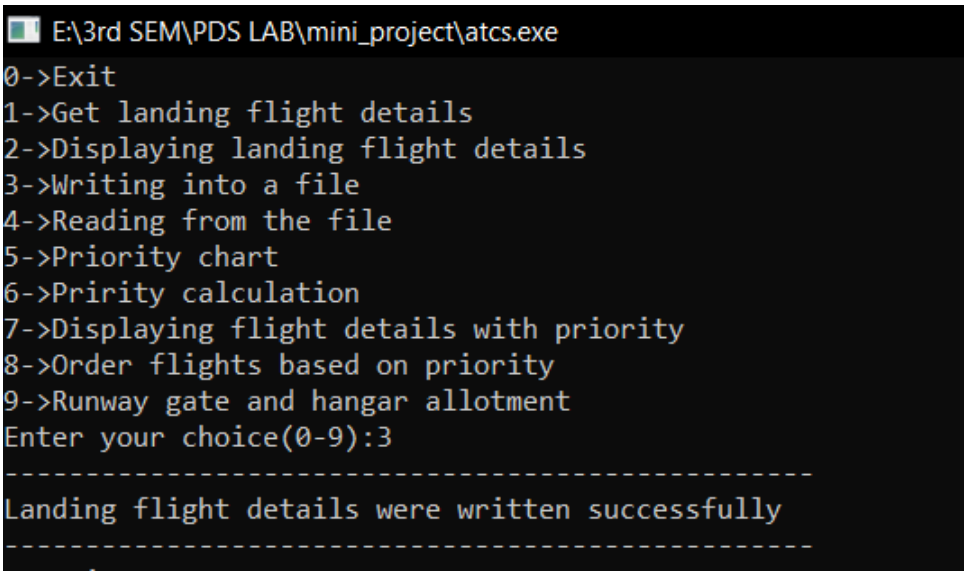
2. Display the landing flight details

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe

0->Exit
1->Get landing flight details
2->Displaying landing flight details
3->Writing into a file
4->Reading from the file
5->Priority chart
6->Pririty calculation
7->Displaying flight details with priority
8->Order flights based on priority
9->Runway gate and hangar allotment
Enter your choice(0-9):2
--------------------------------------------------
Airplane 1
----------
Flight Id    :101
Flight Name  :airindia
Distance     :2.000000
Fuel left    :20.000000
Waiting time :30
--------------------------------------------------
Airplane 2
----------
Flight Id    :102
Flight Name  :spicejet
Distance     :5.000000
Fuel left    :20.000000
Waiting time :14
--------------------------------------------------
Airplane 3
----------
Flight Id    :103
Flight Name  :spicejet
Distance     :7.000000
Fuel left    :20.000000
Waiting time :30
--------------------------------------------------
Airplane 4
----------
Flight Id    :104
Flight Name  :indigo
Distance     :2.000000
Fuel left    :60.000000
Waiting time :8
```



3. Writing the details into a file named ‘land.txt’



4. Reading the file ‘land.txt’

```
--------------------------------------------------
0->Exit
1->Get landing flight details
2->Displaying landing flight details
3->Writing into a file
4->Reading from the file
5->Priority chart
6->Pririty calculation
7->Displaying flight details with priority
8->Order flights based on priority
9->Runway gate and hangar allotment
Enter your choice(0-9):4
-----------------------------------------------------------------------
Flight ID  Flight Name  Distance from runway   Fuel left   Time halt
-----------------------------------------------------------------------
101        airindia            2.000000        20.000000       30
102        spicejet            5.000000        20.000000       14
103        spicejet            7.000000        20.000000       30
104        indigo              2.000000        60.000000       8
105        airindia            20.000000       60.000000       30
106        indigo              10.000000       30.000000       8
107        spicejet            3.000000        20.000000       15
```

5. Display the priority chart of landing flights

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
0->Exit
1->Get landing flight details
2->Displaying landing flight details
3->Writing into a file
4->Reading from the file
5->Priority chart
6->Pririty calculation
7->Displaying flight details with priority
8->Order flights based on priority
9->Runway gate and hangar allotment
Enter your choice(0-9):5

                     Priority chart
                     --------------


-------------------------------------------------------------
|     Paramaters             |  low   |  medium  |   high   |
|------------------------------------------------------------|
|                            | (0-5)  |  (5-8)   |  (8-20)  |
|Distance from runway(in km) |   20   |    10    |     5    |
|------------------------------------------------------------|
|                            | (0-40) |  (40-80) | (80-150) |
|Fuel left (in litres)       |   30   |    20    |    10    |
|------------------------------------------------------------|
|                            | (20-50)|  (10-20) |  (0-10)  |
|Time halt (in minutes)      |    2   |     5    |    10    |
-------------------------------------------------------------
```

6. Priority calculation and displaying flight details with its corressponding priority

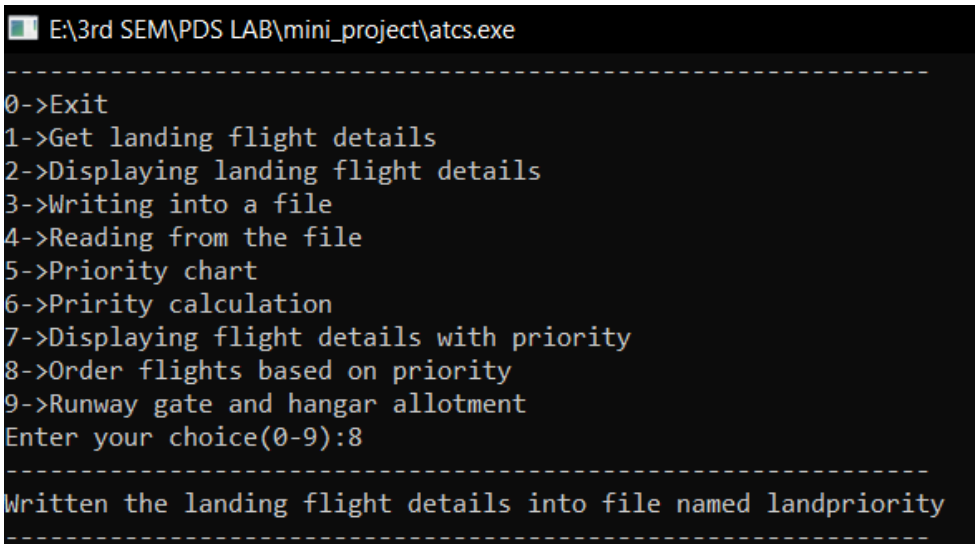
```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe

0->Exit
1->Get landing flight details
2->Displaying landing flight details
3->Writing into a file
4->Reading from the file
5->Priority chart
6->Pririty calculation
7->Displaying flight details with priority
8->Order flights based on priority
9->Runway gate and hangar allotment
Enter your choice(0-9):6
------------------------------------------------------------
Displaying landing flight details after priority calculation
------------------------------------------------------------
Flight No.    Flight ID  Priority value
------------------------------------------------------------
Flight 1        101       60
Flight 2        102       45
Flight 3        103       50
Flight 4        104       42
Flight 5        105       35
Flight 6        106       37
Flight 7        107       55
------------------------------------------------------------
```

7. Displaying the landing flight details in decreasing order based on its priority

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
------------------------------------------------------------
0->Exit
1->Get landing flight details
2->Displaying landing flight details
3->Writing into a file
4->Reading from the file
5->Priority chart
6->Pririty calculation
7->Displaying flight details with priority
8->Order flights based on priority
9->Runway gate and hangar allotment
Enter your choice(0-9):7
------------------------------------------------------------
Ordering of landing flights based on the priority being calculated
------------------------------------------------------------
Flight No.  Flight ID    Name    Priority value
------------------------------------------------------------
1           101         airindia      60
2           107         spicejet      55
3           103         spicejet      50
4           102         spicejet      45
5           104         indigo        42
6           106         indigo        37
7           105         airindia      35
------------------------------------------------------------
```

8. Writing the ordered flight details into a file named ‘landpriority.txt’



9. Runway, gate and hangar allotment of landing flights

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
0->Exit
1->Get landing flight details
2->Displaying landing flight details
3->Writing into a file
4->Reading from the file
5->Priority chart
6->Pririty calculation
7->Displaying flight details with priority
8->Order flights based on priority
9->Runway gate and hangar allotment
Enter your choice(0-9):9
------------------------------------------------------------
Enter number of runways available:2
Enter number of gates available:3
------------------------------------------------------------
Runway gate and hangar allotment
------------------------------------------------------------
Flight id 101 is sent to runway no. 1
------------------------------------------------
Flight id 107 is sent to runway no. 2
------------------------------------------------
Flight id 101 is sent to gate no. 3
------------------------------------------------
Flight id 103 is sent to runway no. 1
------------------------------------------------
Flight id 107 is sent to gate no. 1
------------------------------------------------
Flight id 102 is sent to runway no. 2
------------------------------------------------
Flight id 103 is sent to gate no. 2
------------------------------------------------
Flight id 104 is sent to runway no. 1
------------------------------------------------
Flight id 101 is sent to hangar
------------------------------------------------
Flight id 102 is sent to gate no. 3
------------------------------------------------
Flight id 106 is sent to runway no. 2
------------------------------------------------
Flight id 107 is sent to hangar
------------------------------------------------
Flight id 104 is sent to gate no. 1
------------------------------------------------
Flight id 105 is sent to runway no. 1
------------------------------------------------
------------------------------------------------------------
```

➢ TAKEOFF

1. Get the takeoff flight details

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
Enter your choice(l->Landing,t->TakeOff):t
Takeoff flights
---------------
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):1
-------------------------------------------------
Enter flight details regarding take off:
-------------------------------------------------
Enter the flight id:101
Enter thr flight name:airindia
Enter the departure time(HH:MM:SS):10:20:30
Enter the direction of take off(1-south,2-north,3-east,4-west,5-northeast,6-northwest,7-southeat,8-southwest):west
Enter 0 to stop getting inputs:2
-------------------------------------------------
Enter flight details regarding take off:
-------------------------------------------------
Enter the flight id:102
Enter thr flight name:spicejet
Enter the departure time(HH:MM:SS):20:35:45
Enter the direction of take off(1-south,2-north,3-east,4-west,5-northeast,6-northwest,7-southeat,8-southwest):east
Enter 0 to stop getting inputs:2
-------------------------------------------------
Enter flight details regarding take off:
-------------------------------------------------
Enter the flight id:103
Enter thr flight name:indigo
Enter the departure time(HH:MM:SS):18:23:45
Enter the direction of take off(1-south,2-north,3-east,4-west,5-northeast,6-northwest,7-southeat,8-southwest):north
Enter 0 to stop getting inputs:3
-------------------------------------------------
Enter flight details regarding take off:
-------------------------------------------------
Enter the flight id:104
Enter thr flight name:airindia
Enter the departure time(HH:MM:SS):13:44:55
Enter the direction of take off(1-south,2-north,3-east,4-west,5-northeast,6-northwest,7-southeat,8-southwest):south
Enter 0 to stop getting inputs:2
```

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
-------------------------------------------------
Enter flight details regarding take off:
-------------------------------------------------
Enter the flight id:105
Enter thr flight name:spicejet
Enter the departure time(HH:MM:SS):23:55:35
Enter the direction of take off(1-south,2-north,3-east,4-west,5-northeast,6-northwest,7-southeat,8-southwest):east
Enter 0 to stop getting inputs:2
-------------------------------------------------
Enter flight details regarding take off:
-------------------------------------------------
Enter the flight id:106
Enter thr flight name:airindia
Enter the departure time(HH:MM:SS):15:10:10
Enter the direction of take off(1-south,2-north,3-east,4-west,5-northeast,6-northwest,7-southeat,8-southwest):south
Enter 0 to stop getting inputs:0
```

2. Display the takeoff flight details

```
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):2
----------------------------------------
Airplane 1
-----------
Id              : 101
Name            : airindia
Departure time  : 10:20:30
Direction       : west
----------------------------------------
Airplane 2
-----------
Id              : 102
Name            : indigo
Departure time  : 20:35:34
Direction       : east
----------------------------------------
Airplane 3
-----------
Id              : 103
Name            : spicejet
Departure time  : 14:45:56
Direction       : north
----------------------------------------
Airplane 4
-----------
Id              : 104
Name            : airindia
Departure time  : 23:20:50
Direction       : south
----------------------------------------
```

3. Writing the details into a file named ‘depart.txt’

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
----------------------------------------
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):3
------------------------------------------------
Flight take off details were written successfully
------------------------------------------------
```

4. Reading the file ‘depart.txt’

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):4
-------------------------------------------------------------
Flight ID  Flight Name  Departure time   Direction of takeoff
-------------------------------------------------------------
101        airindia     10:20:30              west
102        spicejet     20:35:45              east
103        indigo       18:23:45              north
104        airindia     13:44:55              south
105        spicejet     23:55:35              east
106        airindia     15:10:10              south
-------------------------------------------------------------
```

5. Priority calculation and displaying flight details with its corressponding priority

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):5
-------------------------------------------------------------
Displaying flight takeoff details after priority calculation
-------------------------------------------------------------
Flight No.   Flight ID  Priority value
-------------------------------------------------------------
Flight 1        101     37230
Flight 2        102     74145
Flight 3        103     66225
Flight 4        104     49495
Flight 5        105     86135
Flight 6        106     54610
-------------------------------------------------------------
```

6. Displaying the takeoff flight details in decreasing order based on its priority

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
------------------------------------------------------------
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):6
------------------------------------------------------------
Ordering of takeoff flights based on the priority being calculated
------------------------------------------------------------
Flight No.  Flight ID    Name   Priority value
------------------------------------------------------------
1          101   airindia       37230
2          104   airindia       49495
3          106   airindia       54610
4          103   indigo 66225
5          102   spicejet       74145
6          105   spicejet       86135
------------------------------------------------------------
```

7. Writing the ordered flight details into a file named ‘departpriority.txt’

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
------------------------------------------------------------
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):7
------------------------------------------------------------
Written the takeoff flight details into file named departpriority
------------------------------------------------------------
```

8. Runway, gate and hangar allotment of takeoff flights

```
E:\3rd SEM\PDS LAB\mini_project\atcs.exe
------------------------------------------------------------
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):8
Enter number of runways available:2
Enter number of gates available:3
------------------------------------------------------------
Runway,gate allotment and take off order
------------------------------------------------------------
Flight id 101 is sent to gate no. 1
-----------------------------------------------------
Flight id 104 is sent to gate no. 2
-----------------------------------------------------
Flight id 106 is sent to gate no. 3
-----------------------------------------------------
Flight id 101 is sent to runway no. 2
-----------------------------------------------------
Flight id 103 is sent to gate no. 1
-----------------------------------------------------
Flight id 104 is sent to runway no. 1
-----------------------------------------------------
Flight id 102 is sent to gate no. 2
-----------------------------------------------------
Flight id 101 is taken off
-----------------------------------------------------
Flight id 106 is sent to runway no. 2
-----------------------------------------------------
Flight id 105 is sent to gate no. 3
-----------------------------------------------------
```

0-EXIT

```
------------------------------------------------------------
0->Exit
1->Get takeoff flight details
2->Displaying takeoff flight details
3->Writing into a file
4->Reading from the file
5->Pririty calculation
6->Displaying flight details with priority
7->Order flights based on priority
8->Runway gate allotment and takeoff order
Enter your choice(0-8):0
Enter your choice(l->Landing,t->TakeOff):e

--------------------------------
Process exited after 586.4 seconds with return value 0
Press any key to continue . . .
```

RESULT

Thus, the air traffic is controlled by managing the landing and departing flights using priority queue implemented using binary heap

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https://github.com/hisham66666/Tj