DYNAMIC RUNWAY AND GATE TERMINAL ALLOCATION FOR FLIGHTS

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Abstract: The objective is to maximize throughput for runway and gate terminal by minimizing the number of unassigned runway flights and ungated flights. The work in the paper deals with the arrangement of flights arrival and departure times such that the throughput for gateway and runway for flights are optimized. The paper suggests the ways for finding an optimum solution for the problem using greedy approach and modifying the existing greedy approach to incorporate the emergency scenarios at airport including flight delays or early arrivals due to bad weather, passenger emergency and likewise other causes. The modified algorithm provided has been demonstrated with a flight simulation UI showing its optimization.

***Index Terms* – Greedy Algorithm, Runway and Gate terminal, Flights, Dynamic Algorithm**

I. INTRODUCTION

With a mean growth rate of more than 5 percentage, the size of global air transportation has gradually increased over last few years. According to International Air Transport Association [11], a yearly growth rate of 5.6 percentage for passengers and of 6.7 percentage for cargo for the next five years for total scheduled international traffic is expected. It is thus more vital to utilize the available resources in an optimum way to deal with these movements. It is thus more vital to utilize the available resources in an optimum way to deal with these movements. [4],[6] Optimal use of ground resources including runway and gate terminal are essential to deal with the increasing air traffic. One way to deal with it is by bringing in more of such resources, which would be helpful for the shorter duration, along with huge financial efforts.

[5] An algorithm is a self-explained series of steps that make set of operations. Algorithm is an useful method which be articulated with a finite amount of time, space and in a formal language for better understanding and evaluating a function. **Interval scheduling** [8] in computer science is a problem set, mainly in the domain of algorithmic design. This considers a set of jobs. An interval showcases each job, which describes the time needed for its execution: Job x running from 3 to 6, job y running from 5 to 11 and job z running from 10 to 12. Our aim is to apply algorithms of interval scheduling to manage runway and gate terminal allocation at airport. The core idea of the work is on assigning runway and gateway to the flights on request on demand. There are two ways according to which one can classify the approaches used to cope up with this scenario: Rule or expert system-based approaches and Optimization based approach.

Problem Definition: “Scheduling of arrival and departure of aircrafts on an airport using interval scheduling by using concept of time windows gate [1] scheduling for flight traffic management with the real time data of an operational airport.”

II. SYSTEM DESIGN

A. Polynomial Solution (Greedy Approach): [14]

1. Choose an interval, i, whose finishing time is the earliest.
2. Delete i, along with the intersecting intervals with i, in appropriate interval set.
3. Repeat 2 and 3 till appropriate interval sets are empty.

In the above approach several intervals might be required to be removed. Yet entire set of intervals compulsorily cut the finish time of i, so do they cut one another. Henceforth, maximum one of the cutting intervals will provide a solution. The proof that greedy approach is an optimal solution but locally can be seen when, for each interval in the solution that is optimum, there exist an interval for the solution by greedy approach

A Charging argument provides a better formal expression. The above greedy algorithm is executed in O(n log n), n-> no. of jobs, jobs are sorted by their finish times, with help of a pre-processing step.

B. Greedy Algorithm (Minimum Number of Resources):[14]

[1] Complete the jobs sorting according to their finish times such that $f1 \leq f2 \leq ... \leq fn$.

[2] $X \leftarrow \varphi$

[3] for k = 1 to n

```
    {
      if (job k consistent with X)
      X ← X ∪ {k}
    }
return X
```

Time Complexity: O(n)

C. Greedy Algorithm (Maximum Number of Resources): [14]

[1] Complete the jobs sorting according to their start times such that $s1 \leq s2 \leq ... \leq sn$.

$y \leftarrow 0$

[2] for m = 1 to n {

```
if (flight m is matches gate g, 1≤g≤y)
schedule flight m for gate g
else
assign a gate y + 1
schedule flight m in gate y + 1
y ← y + 1
}
```

Time Complexity: O(n)

D. Optimal Greedy Approach: [15]

[1] Start
[2] Accept all task
[3] Arrange all the task in the order of earliest finish time (do sorting according to earliest finish time).
[4] I=1 ⟶ n
[5] Enqueue job Ji
[6] If job Ji+1 is non conflicting or non overlapping Enqueue job Ji+1
[7] Else neglect job
[8] End

Time Complexity: O(nlogn)

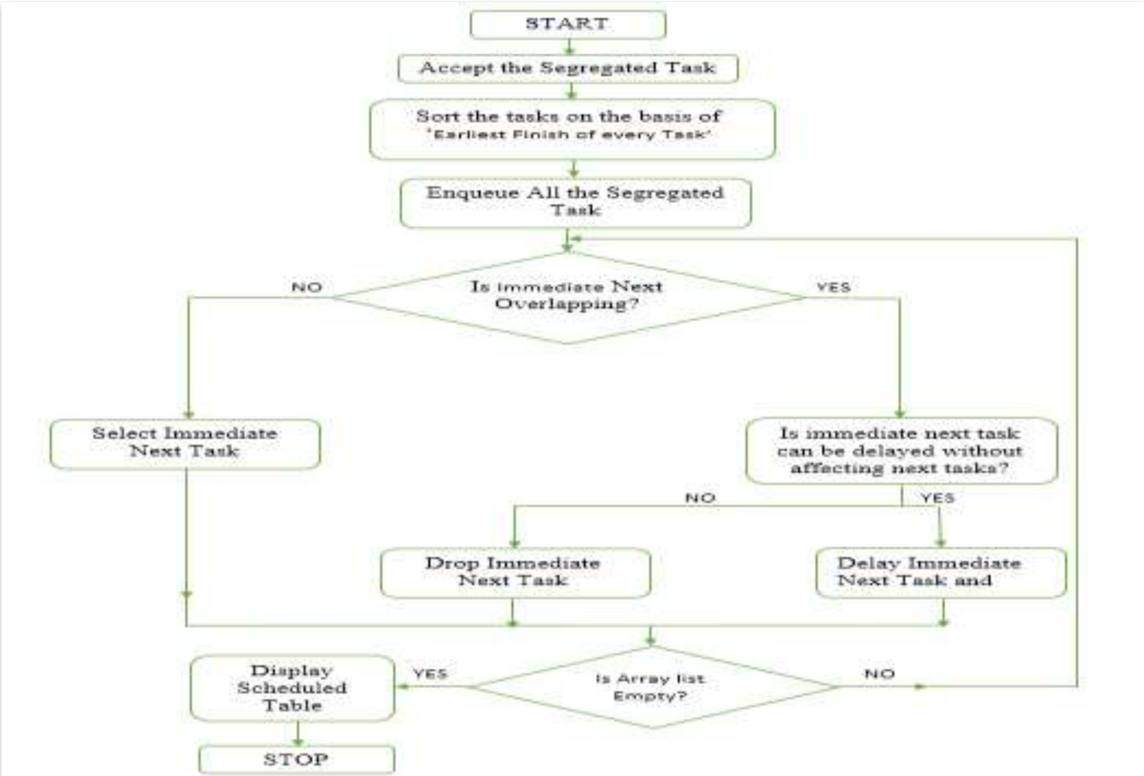

Figure 1: Flowchart of Modified greedy approach

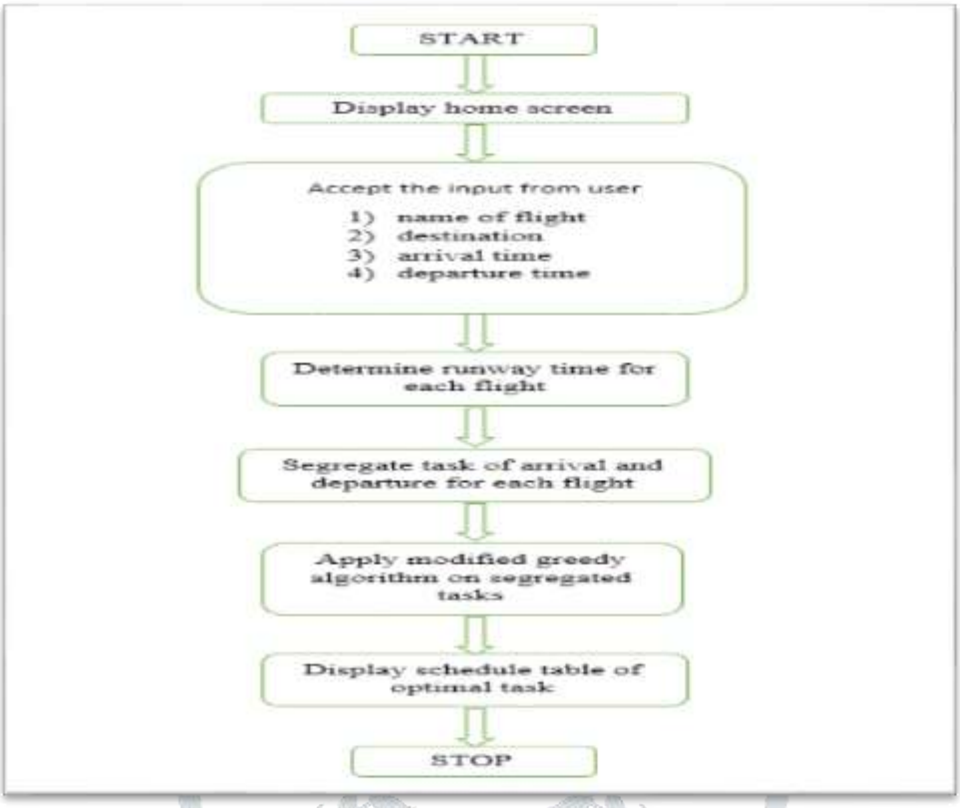

Figure 2: Flowchart of Flight Scheduling using Modified Greedy Approach

Figure 3: Input to the Interval Scheduling Algorithm [3]

The [3] flowcharts (Fig 1 and Fig2) shows the testing input to the greedy approach of an interval scheduling algorithm. In Fig 3 : 49-60, 28-40, etc are the arrival and departure time of aircraft. Here 49 is arrival time and 60 represents the departure time of flight.

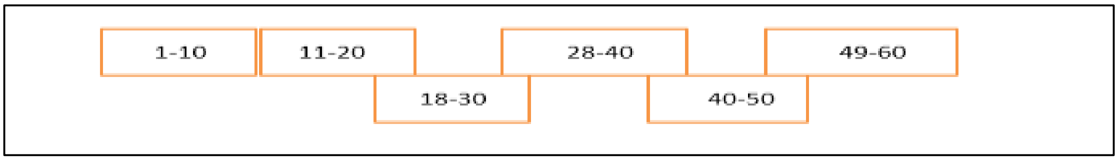

Figure 4: Sorted Intermediate Output

The diagram in (Fig 4) shows the sorted output according to the earliest arrival and earliest finish time of flight. Because of earliest finish time taking into consideration utilization of rum way time must be optimized.

1-3 8-10	11-13 18-20	28-30 38-40	31-33 34-40	41-43 48-50	51-53 58-60

Figure 5: Final Output Flight Scheduled Table

Here in (Fig 5) the final output of the Greedy approach of interval scheduling algorithm is displayed. In the (Fig 5) 1-3 means, [13]aircraft will required 2 min of runway to take off hence 2 min is nothing but runway time for a flight.

Algorithm Input Information:

[1] Taking Bangalore Airport time table as a test input for Dynamic runway allocation algorithm.

[2] 1st column of above input is source airport from which flight do take-off.

[3] 2nd column is destination airport.

[4] 3rd column of input is Flight ID.

[5] Next column input is ETD or ETA i.e. Expected time departure or Expected time arrival from source airport or to destination airport.

III. RESULTS AND OBSERVATIONS


Fights Request

Flight Id	Gateway Start Time	Gateway Finish Time	Delayed Time	Flight Information	Status
AI0505	8:15	-	-	ATR-42	departing
AI0364	15:30	-	-	A-320	departing
AI0804	5:55	-	-	A-320	departing
AI0604	6:15	-	-	A-320	departing
AI0505	10:30	-	-	B787	departing
AI0501	13:30	-	-	A-320	departing
AI0503	16:30	-	-	A-320	departing
AI0404	20:15	-	-	B787	departing
AI0993	17:45	-	-	A-319	departing
AI0513	8:15	-	-	A-319	departing
AI0993	17:45	-	-	A-319	departing
AI0513	8:15	-	-	A-319	departing
AI0977	17:30	-	-	A-319	departing
AI0516	18:50	-	-	A-319	departing
9I3505	8:15	-	-	ATR-42	departing
AI0772	6:05	-	-	A-319	departing
AI0263	7:35	-	-	A-320	departing
AI0265	11:45	-	-	A-319	departing
AI0640	6:45	-	-	A-319	departing
AI0604	8:30	-	-	A-319	departing
AI0610	19:00	-	-	A-320	departing
AI0608	21:20	-	-	A-319	departing
AI0977	17:30	-	-	A-319	departing
9I3513	6:00	-	-	ATR-42	departing
9I3509	15:35	-	-	ATR-42	departing
AI0513	8:15	-	-	A-319	departing
AI0263	7:35	-	-	A-319	departing
9I3506	15:10	-	-	ATR-42	arriving
AI0263	6:55	-	-	A-320	arriving
AI0803	9:20	-	-	B787	arriving
AI0506	12:05	-	-	A-320	arriving
AI0508	12:30	-	-	A-320	arriving
AI0502	15:45	-	-	A-320	arriving
AI0403	19:15	-	-	B787	arriving
AI0504	22:50	-	-	A-320	arriving
AI0994	5:45	-	-	A-319	arriving
AI0994	5:45	-	-	A-319	arriving
AI0994	5:45	-	-	A-319	arriving
AI0514	18:10	-	-	A-319	arriving
AI0978	4:45	-	-	A-319	arriving
AI0515	7:35	-	-	A-319	arriving
AI0514	18:10	-	-	A-319	arriving
AI0988	9:00	-	-	A-320	arriving
9I3506	15:10	-	-	ATR-42	arriving
AI0771	20:40	-	-	A-319	arriving

Figure 6: Input unscheduled Time Table

The Table in (Fig 6) displays the input containing [10] Gateway start time and Gateway finish time. Also, the last column displays the status of the flight i.e. arriving or departing from a specific Gate.

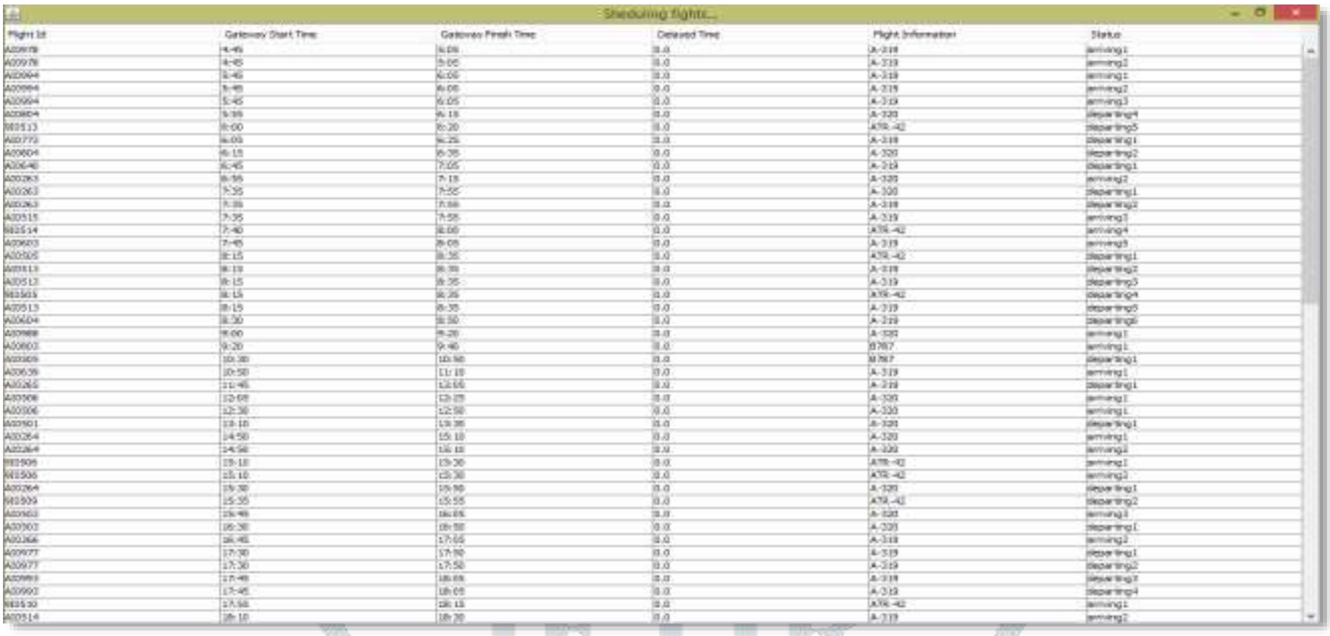

Figure 7: Scheduled Time Table Using Greedy Approach

The table in the (Fig 7) displays the output of the dynamic runway allocation. Last column will display the status of flight from which the flight is arriving or departing.

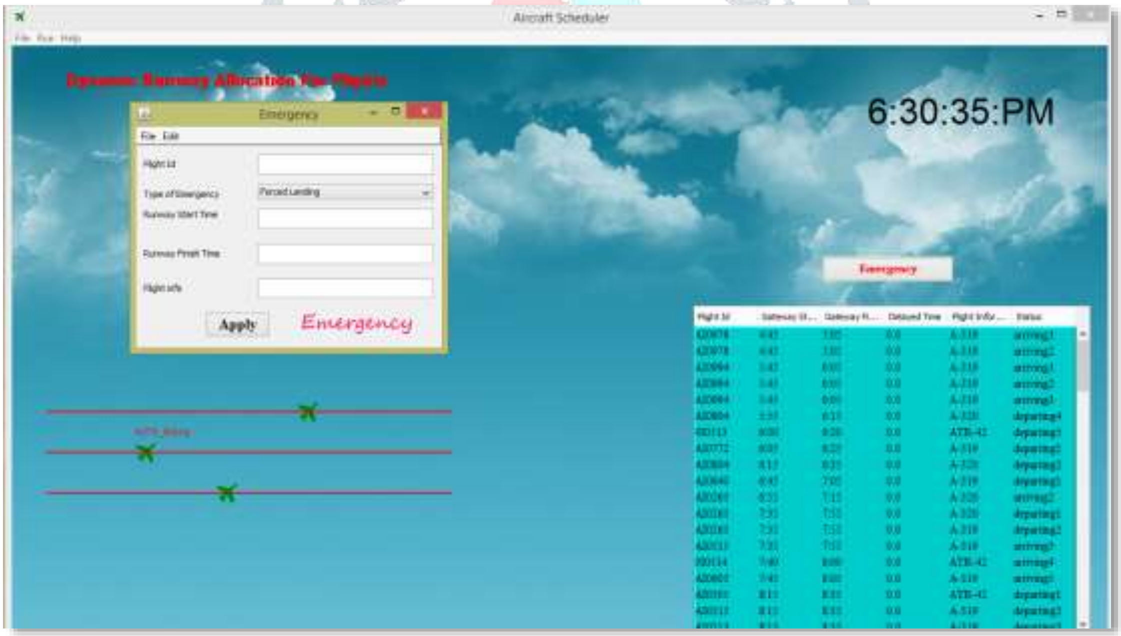

Figure 8: Flight Scheduler Handling Emergency by accommodating 80% of the new flight requests

UI [2] screen shot is displayed in the (Fig 8) that shows application having an option to handle the emergencies due to [7], [9] force landing, bad weather, flight technical problem, etc. along with the table showing flights accommodated due to these emergencies. The table in (Fig 8) displays the list of new flights that are assigned gate terminals. The number of flight requests accommodated by the algorithm proved to be 80% of the total flight requests.

IV. CONCLUSION

This paper provides efficient method as solution and presentes new applications for a generalized group of deterministic, non-pre-emptive scheduling models. The project was able to find a local optimum for the defined problem in the paper through a greedy algorithm. The above approach of using greedy algorithm proved to have a time complexity of **O(nlogn).**

For the test data, greedy algorithm verified to accommodate new 80% of the new flight requests as displayed the list of new requested flights which were absent in previously used greedy algorithm with time complexity O(n). The reason being that our algorithm deals with the allocation of resources over time to activities, the start of which is restricted by minimum and maximum flight time delays, also these delays allow to specify any possible temporary relation between sets of events.

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