# DYNAMIC RUNWAY AND GATE TERMINAL ALLOCATION FOR FLIGHTS

<sup>1</sup> Bernard Lewis, <sup>2</sup> Dr. R.C. Jaiswal
 <sup>1</sup>Student, <sup>2</sup>Professor
 <sup>1</sup>Department of Electronics and Telecommunication,
 <sup>1</sup>Pune Institute of Computer Technology, Pune, India

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  $f_1 \le f_2 \le ... \le f_n$ .
- $[2] \quad X \leftarrow \varphi$
- [3] for k = 1 to n

```
if (job k consistent with X)
X \leftarrow X \cup \{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 ≤ s2 ≤ ... ≤ sn.
   y ← 0
- [2] for m = 1 to  $n \{$

```
if (flight m is matches gate g, 1 \le g \le y)
schedule flight m for gate g
else
assign a gate y + 1
schedule flight m in gate y + 1
y \leftarrow y + 1
```

```
ł
```

# 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)

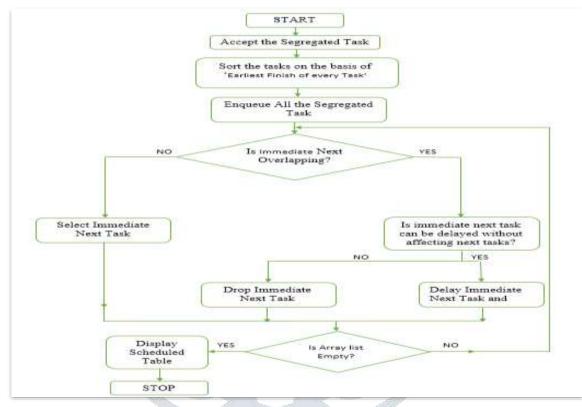


Figure 1: Flowchart of Modified greedy approach

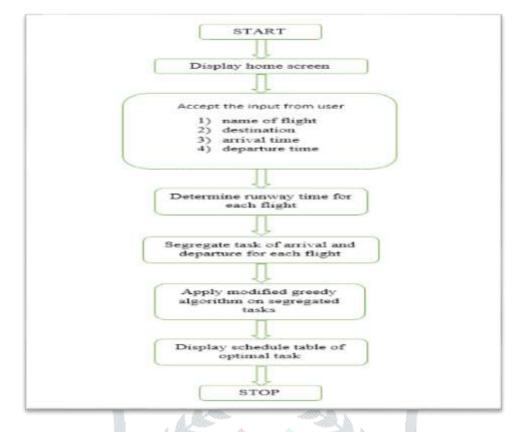


Figure 2: Flowchart of Flight Scheduling using Modified Greedy Approach

1000 0000 22	
	- 60
	45
	28-00
	2.10
	18-30 40-50 11-20
	18.
	10.50
	and a lateral state of the stat
	11-20

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.

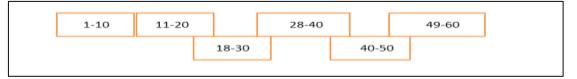


Figure 4: Sorted Intermediate Output

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.

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] 1<sup>st</sup> column of above input is source airport from which flight do take-off.
- [3]  $2^{nd}$  column is destination airport.
- [4]  $3^{rd}$  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**

el		And a second sec	Fights Request		- 8
Hight Id .	Goteway Start Tive	Gateway Finish Time	Delayed Time	Fight Information	Satur
AIDSES	8:15	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	COM # 2007	ATR 42	(departing
AIDO64	15:30			A-320	departing
A00804	0:55			A-320	departing
40804	8:15	-		A-320	(departing
A10585	10:30			0707	departing
A00961	12:30			A-320	depenting
40640	16-30		-	4-320	ideparting
420404	20:15			8787	depenting
40953	17:45		2 C	A-315	departing.
40513	8:15		2	A-319	departing
40993	12:45			A-319	deperting
A00513	8115	-		A-319	departing.
A10977	17:30			A-119	departing
A(0516	18:50			A-219	departing.
N0505	8:15	-		ATR-42	(departing
A10772	6:05			A-319	departing
400263	Vh 36			A-320	departing
ADDRS .	11/45			A-119	departing
4006-40	6:45		-	A-319	departing
40624	8130			A-219	(departing
A206.10	19:00			A-120	departing
420668	21:20			A-519	departing.
40977	17:30		-	A-219	departing
00513	6:00			ATR-42	departing
111509	15:35			ATR-42	ideparting
A10513	<b>魚</b> 15	-		A-319	departing
400263	7:35			A-319	departing
913506	15(10			ATR-42	arriving
40063	8:55			A-320	arriving
400803	5:20			8787	arriving
40506	12/05		1	A-320	artiving
40586	12:30		2	A-520	erriving
40502	15:45			IA-320	arriving
A00403	15115		100 A	8787	latitiong
A00504	32:90		2	A-320	articity
40994	5:+5			A-319	proving
VID994	5:45			A-319	Jerning .
A00994	3:45	1		A-319	arriving
40614	18:10			A-329	errhong
AD979	445			A-319	armong
400515	7:35			A-329	errhong
40514	18:30			A-319	aming
400988	9:00			A-320	anthying
H11506	15:30			ATR-42	arriving
AU0/721	20:40		1	A-319	among

#### 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.

Al			Sheduling flights		- 0	1 100
Pignt 3d	Gatewoy Shart Time	Gatoway Pinds Time	Detailed Time	Plight Sufermation	Sister	
109119	14-15	N DN	3.0	De-Date	arriving I	
909 Ali	4-6	5.05	8.0	8-319	amenal	
D094	2-6	6:00	11.0	A-319	eming:	
0004	3.40	wide.	10.0	A-215	antiting2	_
0994	5-6	6.05	8.0	4.313	aming3	
0804	3.39	6.18	8.0	A-323	Department.	
0513	8:00	8:20	1.0	478.42	more in s5	
0772	a.03	8.75	1.0	8-310	Departing 1	
9604	16.15	6.35	0.0	A-320	IRD#THQ2	
0646	6.46	7:05	9.0	A-213	department.	_
0263	8.16	7-18	0.0	A-030	emest2	
0263	5.8	7.58	1.0	A-300	Sepermul.	
0.043	N.86	1.00	- 11.0	A-318		
0515	7.35	7.58	0.0	A 219	Departmig/2	
1514	2.40	32.00	1.0	14-1519 14-151-142	enviring 1	
					arriving4	
0623	7:45	8.05	0.0	A-219	activity 3	
04906	IE15	8.56	0.0	4790	1965# Wig1	
1813	94.19	8.99	10.0	A-318	(Rejust 1942)	
95£7	)作(当	<b>赴</b> 35	8.0	A-319	page trig3	
1505	14:15	8,25	0.0	3/08-42	Port water	
0513	0.15	8:35	0.0	A-339	000919105	
0604	34:50	11 M	1.4	A-219	paper trigs	
CTNE#	18.00	9-20	3.0	A-332	an manager	
0803	9.20	9.40	1.0	8267	enving1	
0309	10130	10:50	0.0	A8 76 7	departing1	
0639	10:50	Ltr 10	0.0	A-319	arriving 1	
6265	22.45	12.00	0.0	A 019	pearing).	
0006	12-98	12-25	18.07	4-333	aming[	
0306	12:30	12:50	0.0	A-535	arriving L	
0501	128-18	10.00	in.a	8-320	ineuership1	
0264	1450	15 10	0.0	A-320	errorg1	
0.0.4	14.98	18.10	11.0	A-300	among l	
1909	15.18	13:20	0.0	A79:-01	1 priving I	
1505	15.10	(2.3)	3.4	A'R -0	aming2	
0264	15:30	15:50	8.0	A-121	steparting1	
1909	15.35	15.55	8.0	A12.41	deperting2	
oned.	18.49	16:25	11.07	A-124	aming3	
7901	16:31	10-10	0.0	A-205		_
2366	26.45	1765	6.0		Heperting I.	
	12/30		11.0	4-319	leiniirg2	_
09077		结婚			riteser ling I	
0977	17.30	17.50	0.0	A-319	Deciw Wrig2	
owers	17-49	18.09.	18.02	4/018	100 W 100 T	
1997	17:48	101-05	ja α.	A-319	18p#1rg1	
35 30	17.68	18:15	9,0	A78-42	aming1	
0514	10-10	18:20	10,0	A-717	general C	

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.

Fire Life         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Ence	Note:         Concercion         Concercion         Note:           April:         Interactioning         Interactioning         Interactioning         Interactioning           Reversitive:         Protectioning         Interactioning         Interactioning         Interactioning           Apply         Encoding         Interactioning         Interactioning         Interactioning         Interactioning           Apply         Encoding         Encoding         Encoding         Interactioning         Interactioning         Interactioning           Apply         Encoding         Encoding         Encoding         Interactioning         Interactioning         Interactioning           Apply         Encoding         Encoding         Interactioning	for the				Altera	t Scheduler						
Fire Life         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Ence				illen das me					-				
Fire Life         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Encergency         Encergency         Print Lisening         Print Lisening         Print Lisening         Print Lisening           Apply         Ence			101	Emergence			1000		a state	6	5:30	:35:	PM
Importance         Presidence           Access that The         Interaction           Apply         Encergency           Apply         Encergency <td>Tree of thereights         Windfunding         Windfunding<td></td><td>File Eile</td><td></td><td></td><td></td><td>1.0</td><td>1000</td><td></td><td></td><td>100</td><td></td><td></td></td>	Tree of thereights         Windfunding         Windfunding <td></td> <td>File Eile</td> <td></td> <td></td> <td></td> <td>1.0</td> <td>1000</td> <td></td> <td></td> <td>100</td> <td></td> <td></td>		File Eile				1.0	1000			100		
Importance         Presidence           Access that The         Interaction           Apply         Encergency           Apply         Encergency <td>Tree of thereights         Windfunding         Windfunding<td></td><td>interior (</td><td></td><td>- 11</td><td>Sec. 18</td><td>100 million (1997)</td><td>- 1</td><td></td><td></td><td>and the second</td><td></td><td></td></td>	Tree of thereights         Windfunding         Windfunding <td></td> <td>interior (</td> <td></td> <td>- 11</td> <td>Sec. 18</td> <td>100 million (1997)</td> <td>- 1</td> <td></td> <td></td> <td>and the second</td> <td></td> <td></td>		interior (		- 11	Sec. 18	100 million (1997)	- 1			and the second		
Revent that Tree         Dense True Tree           Apply         Encergency           Apply         Encergency <td>Accust that Tree         Interceptory           Agebr         Encergency           Agebr         Encergency</td> <td></td> <td></td> <td></td> <td></td> <td>1.000</td> <td>and the second</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Accust that Tree         Interceptory           Agebr         Encergency					1.000	and the second						
Notest from Trie         Remain //         Datest from Trie         Remain //         Datest from Trie         Point //         Point //         Datest from Trie         Point //	Apply         Encerngency           Marine         Marine           Marine <td></td> <td>Type of Sovergency</td> <td>Percebunding</td> <td>*</td> <td></td> <td>Cold Party of the Party of the</td> <td>1000</td> <td>-</td> <td></td> <td></td> <td></td> <td></td>		Type of Sovergency	Percebunding	*		Cold Party of the	1000	-				
Apply         Encergency	Apply         Encergency		Renay Mart Tree			ALC: NO		and the second					
Apply         Encergency	Apply         Encergency					1.000							
Apply         Envergency         Parts         Strength         Date of Tre         Parts         Addes         Addes <thaddes< th=""> <thaddes< th="">         Addes<td>Apply         Encargency           Mark         400         60</td><td></td><td>Rutinia: Presit Time</td><td></td><td></td><td></td><td></td><td></td><td></td><td>-</td><td>-</td><td></td><td></td></thaddes<></thaddes<>	Apply         Encargency           Mark         400         60		Rutinia: Presit Time							-	-		
Apply         Encargency         Normal PL         Datase PL         D	Apply         Encargency         Note of the second		and the second s							Fee	a Start A		
App?         Entergenceg         Ganta         etc         100         A 318         annegt           Conva         6.0         1.00         A 318         annegt         Conva         6.0         A 318         annegt           Conva         6.0         1.00         A 318         annegt         Conva         6.0         A 318         annegt           Apps         1.00         A 318         annegt         Conva         6.0         A 318         annegt           Apps         1.00         A 318         annegt         Apps         6.0         A 318         annegt           Apps         1.00         A 318         annegt         Apps         6.0         A 318         annegt           Apps         6.0         6.0         A 318         annegt         Apps         annegt           Apps         6.0         6.0         A 318         annegt         Apps         annegt           Apps         6.0         6.0         A 318         annegt         Apps         Apps         Apps           Apps         6.0         A 318         annegt         Apps         Apps         Apps         Apps           Apps         6.0         A 318<	Apply         Entrogency         0004         etc         100         A0         A104         annegt           00071         40         100         60         A114         annegt           00071         40         100         60         A114         annegt           00071         40         600         60         A114         annegt           00071         40         600         60         A114         annegt           00071         40         600         60         A118         annegt           00071         401         600         60         A118         annegt           00071         401         600         60         A118         annegt           0008         431         60         60         A118         annegt           0008         431         60         60         A118         annegt           00014         431		Hightarte			1000							
App?         Entergenceg         Ganta         etc         100         A 318         annegt           Conva         6.0         1.00         A 318         annegt         Conva         6.0         A 318         annegt           Conva         6.0         1.00         A 318         annegt         Conva         6.0         A 318         annegt           Apps         1.00         A 318         annegt         Conva         6.0         A 318         annegt           Apps         1.00         A 318         annegt         Apps         6.0         A 318         annegt           Apps         1.00         A 318         annegt         Apps         6.0         A 318         annegt           Apps         6.0         6.0         A 318         annegt         Apps         annegt           Apps         6.0         6.0         A 318         annegt         Apps         annegt           Apps         6.0         6.0         A 318         annegt         Apps         Apps         Apps           Apps         6.0         A 318         annegt         Apps         Apps         Apps         Apps           Apps         6.0         A 318<	Apply         Entrogency         0004         etc         100         A0         A104         annegt           00071         40         100         60         A114         annegt           00071         40         100         60         A114         annegt           00071         40         600         60         A114         annegt           00071         40         600         60         A114         annegt           00071         40         600         60         A118         annegt           00071         401         600         60         A118         annegt           00071         401         600         60         A118         annegt           0008         431         60         60         A118         annegt           0008         431         60         60         A118         annegt           00014         431									and a literature			
CONT         4.0         3.0         4.0.	00000         4.0         0.0         4.0		1 Proprietor	21 I petro 200	100000			Webs Si	Interior II.	Date of the local division of the local divi	Detaued Tree	Patrinky	Table .
AX864         AU         AV         AU	A0096         142         A01         0.01         A.218         except           A0096         1.81         6.00         0.01         A.218         except           A0096         1.81         6.00         0.01         A.218         except           A0096         1.81         6.00         0.01         A.218         except           A0096         2.91         6.01         0.01         A.218         except           A0097         A00         6.01         A.218         except         except           A0097         A01         6.02         0.01         A.218         except           A0096         6.20         7.01         A.218         except         except           A0016         6.21         7.01         A.218         except         except           A0016         7.01         A.218         except         except         except           A0		Apply	Energ	ency						1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
Allowed         Labore         Labore <thlabore< th=""> <thlabore< th=""> <thlabore< t<="" td=""><td>Access         Ball         Open         0.3         Actility         attrange           Access         Ball         Open         0.3         Actility         departure           Access         Call         Open         0.3         Actility         departure           Access         Call         Open         Open         Actility         Actility         Actility           Access         Call         Call         Open         Actility         Actility         Actility         Actility           Actility</td><td></td><td>Apply</td><td>Enverg</td><td>ency</td><td></td><td></td><td>CONTE T</td><td>642</td><td>3.80</td><td>100</td><td>A3.0</td><td>arringt</td></thlabore<></thlabore<></thlabore<>	Access         Ball         Open         0.3         Actility         attrange           Access         Ball         Open         0.3         Actility         departure           Access         Call         Open         0.3         Actility         departure           Access         Call         Open         Open         Actility         Actility         Actility           Access         Call         Call         Open         Actility         Actility         Actility         Actility           Actility		Apply	Enverg	ency			CONTE T	642	3.80	100	A3.0	arringt
X         XXXXX         XXXXXX         XXXXXX         XXXXXX         XXXXXX         XXXXXX         XXXXXX         XXXXXX         XXXXXX         XXXXXXX         XXXXXXX         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Allow         2.31         6.31         0.03         A/130         departing           Allow         Allow         6.28         0.01         6.28         0.01         A/10-12         departing           Allow         Allow         6.29         0.0         A/20-12         departing           Allow         Allow         6.29         0.0         A/20-12         departing           Allow         Allow         Allow         6.29         0.0         A/20-12         departing           Allow         Allow </td <td></td> <td>Apply</td> <td>Enterg</td> <td>ency</td> <td></td> <td></td> <td>620878</td> <td>642</td> <td>加加</td> <td>100</td> <td>A-318 A-318</td> <td>arring1 arring2</td>		Apply	Enterg	ency			620878	642	加加	100	A-318 A-318	arring1 arring2
ATTE 13         STRIE         STRIE         STRIE         STRIE         ATTE-12         departing departing           ATTE-12         ADDRE         ALTE         ADDRE         ALTE         ADDRE         ALTE         ADDRE           ATTE-12         ADDRE         ALTE         ADDRE         ALTE         ADDRE         ALTE         ADDRE           ADDRE         ALTE         ADTE         ADTE         ADTE         ADTE         ADTE         ADTE           ADTE	Altin         Altin <th< td=""><td></td><td>Apply</td><td>Enterg</td><td>ency</td><td></td><td></td><td>620678 623678 623666</td><td>40 40 147 141</td><td>122 122 602</td><td>400 000 000</td><td>A-318 A-318 A-318</td><td>arring1 arring1</td></th<>		Apply	Enterg	ency			620678 623678 623666	40 40 147 141	122 122 602	400 000 000	A-318 A-318 A-318	arring1 arring1
Alter         Alter <th< td=""><td>Alterna         Alterna         <t< td=""><td></td><td>Apply</td><td>Enverg</td><td>ency</td><td>J</td><td></td><td>421078 422078 422064 422064</td><td>402 402 342 343 344</td><td>112 112 112 112 112 112</td><td>400 000 000</td><td>A-119 A-118 A-219 A-219</td><td>arring1 arring1 arring1 arring2</td></t<></td></th<>	Alterna         Alterna <t< td=""><td></td><td>Apply</td><td>Enverg</td><td>ency</td><td>J</td><td></td><td>421078 422078 422064 422064</td><td>402 402 342 343 344</td><td>112 112 112 112 112 112</td><td>400 000 000</td><td>A-119 A-118 A-219 A-219</td><td>arring1 arring1 arring1 arring2</td></t<>		Apply	Enverg	ency	J		421078 422078 422064 422064	402 402 342 343 344	112 112 112 112 112 112	400 000 000	A-119 A-118 A-219 A-219	arring1 arring1 arring1 arring2
AXX80         X,2         X,2         X,3         X,2         X,2         Vertice           40044         6,05         7,00         7,7         X,2         Vertice           40044         6,05         7,00         7,7         X,2         Vertice           40044         6,05         7,10         X,2         Vertice         Vertice           40044         6,05         7,10         X,2         Vertice         Vertice           40045         6,05         7,10         X,2         Vertice         Vertice           40045         7,20         7,10         X,3         X,2         Vertice           40045         7,10         X,3         X,3         X,3         Vertice           40045         7,10         X,3         X,3         X,3         Vertice           40045         7,10         X,3         X,3         X,3         X,3 <t< td=""><td>Allitie         R12         R23         0.0         A 73%         Approxing Approximation           Allitie         0.20         700         A 73%         Approximation           Allitie         0.20         700         A 73%         Approximation           Allitie         0.20         700         A 73%         Approximation           Allitie         0.20         710         0.0         A 23%           Allitie         2.20         751         0.0         A 23%           Allities         2.20         751         0.0         A 23%           Allities         2.20         751         0.0         A 23%           Allities         720         731         0.0         A 24%           Allities         720         731         0.0         A 24%           Allities         730         731         0.0         A 24%           Allities         730         731         0.0         A 24%           Allities         730         731         0.0         A 24%           Allities         84%         84%         84%         A 24%           Allities         84%         84%         84%         A 24%      <tr< td=""><td></td><td>Apply</td><td>Enverg</td><td>ency</td><td>_</td><td></td><td>00074 02078 02064 02064 02064</td><td>402 402 342 343 344</td><td>132 132 610 610 610</td><td>0.0 0.0 0.0 0.0 0.0</td><td>A-110 A-110 A-110 A-110 A-110</td><td>arring1 arring1 arring1 arring2 arring1</td></tr<></td></t<>	Allitie         R12         R23         0.0         A 73%         Approxing Approximation           Allitie         0.20         700         A 73%         Approximation           Allitie         0.20         700         A 73%         Approximation           Allitie         0.20         700         A 73%         Approximation           Allitie         0.20         710         0.0         A 23%           Allitie         2.20         751         0.0         A 23%           Allities         2.20         751         0.0         A 23%           Allities         2.20         751         0.0         A 23%           Allities         720         731         0.0         A 24%           Allities         720         731         0.0         A 24%           Allities         730         731         0.0         A 24%           Allities         730         731         0.0         A 24%           Allities         730         731         0.0         A 24%           Allities         84%         84%         84%         A 24%           Allities         84%         84%         84%         A 24% <tr< td=""><td></td><td>Apply</td><td>Enverg</td><td>ency</td><td>_</td><td></td><td>00074 02078 02064 02064 02064</td><td>402 402 342 343 344</td><td>132 132 610 610 610</td><td>0.0 0.0 0.0 0.0 0.0</td><td>A-110 A-110 A-110 A-110 A-110</td><td>arring1 arring1 arring1 arring2 arring1</td></tr<>		Apply	Enverg	ency	_		00074 02078 02064 02064 02064	402 402 342 343 344	132 132 610 610 610	0.0 0.0 0.0 0.0 0.0	A-110 A-110 A-110 A-110 A-110	arring1 arring1 arring1 arring2 arring1
ADDR+         8,15         8,25         9,03         +1,71         4ylaring           40,0040         4,051         7,00         9,70         4,70         6ylaring           40,0040         4,051         7,00         9,70         4,70         6ylaring           40,0040         4,051         7,00         8,70         4,70         6ylaring           40,0040         4,51         1,51         9,0         4,20         6ylaring           40,0040         4,51         1,51         9,0         4,20         6ylaring           40,0040         2,51         1,51         9,0         4,20         6ylaring           40,0040         7,51         1,51         9,0         4,20         6ylaring           40,0040         7,51         1,51         0,0         4,20         6ylaring           40,0040         7,51         1,51         0,0         4,214         attraction           40,0040         7,92         1,51         0,0         4,214         attraction           40,0040         7,94         9,90         0,0         4,714,42         attraction           40,0040         7,94         9,90         0,0         4,514         attracti	ADDR#         R.12         R.23         R.0         A.73         Arguments           ADDR#         R.01         7.00         R.0         A.23         Arguments           ADDR#         2.20         T.51         R.0         A.23         Arguments           ADDR#         R.00         R.0         A.23         Arguments         Arguments           ADDR#         R.10         R.0         A.23         Arguments         Arguments           ADDR#         R.10         R.0         A.24         Arguments         Arguments <td< td=""><td></td><td></td><td>Enverg</td><td>ency</td><td></td><td></td><td>00978 02978 02978 02999 02999 02999 02999 02999 02999 02999 02999 02999 02999 02999 02999 02997 02997 02978 020778 02070 00000000</td><td>80 80 10 10 10 10 10 10 10 10 10 10</td><td>132 132 800 800 810 810 825</td><td>84 80 80 80 80 80 80 80 80</td><td>A-110 A-210 A-210 A-210 A-210 A-210 A-210 A-210 A-210</td><td>arring1 arring2 arring2 arring2 arring2 departagi departagi</td></td<>			Enverg	ency			00978 02978 02978 02999 02999 02999 02999 02999 02999 02999 02999 02999 02999 02999 02999 02997 02997 02978 020778 02070 00000000	80 80 10 10 10 10 10 10 10 10 10 10	132 132 800 800 810 810 825	84 80 80 80 80 80 80 80 80	A-110 A-210 A-210 A-210 A-210 A-210 A-210 A-210 A-210	arring1 arring2 arring2 arring2 arring2 departagi departagi
ADDRE         0.01         7.01         9.01         A.519         Angenta           ADDRE         0.01         1.21         9.01         A.520         angenta           ADDRE         2.31         1.51         9.0         A.520         angenta           ADDRE         2.31         1.51         9.0         A.520         Appatha           ADDRE         2.31         1.51         9.0         A.210         Appatha           ADDRE         7.01         1.51         9.0         A.210         Appatha           ADDRE         7.01         1.51         9.0         A.210         angenta           ADDRE         7.01         1.51         9.0         A.210         angenta           ADDRE         7.01         1.51         9.0         A.210         angenta           ADDRE         7.01         1.51         0.0         A.210         angenta           ADDRE         7.01         1.51         0.0         A.210         angenta           ADDRE         8.00         8.00         A.010         angenta           ADDRE         8.00         8.00         A.010         angenta           ADDRE         8.00         8.0	ADD44         0.40         2.20         0.0         A.219         depresso           ADD46         0.50         1.11         0.0         A.220         depresso           ADD46         0.51         1.11         0.0         A.200         depresso           ADD46         0.51         1.51         0.0         A.200         depresso           ADD400         0.21         1.51         0.0         A.200         depresso           ADD100         2.20         1.51         0.0         A.200         depresso           ADD100         2.21         1.00         A.200         depresso         depresso           ADD100         2.21         8.00         A.200         A.200         depresso           ADD100         8.00         A.200         A.200         A.200         A.200         depresso           ADD100         8.00         A.200         A.200         A.200			Enverg	ency			00075 (2007) (2007) (2006) (2006) (2006) (2006) (2010) (2010) (2011) (2017)	40 40 10 10 10 10 10 10 10 10 10 10 10 10 10	130 130 800 600 610 628 628	84 80 80 80 80 80 80 80 80 80 80 80	A 318 A 318 A 318 A 318 A 318 A 318 A 318 A 318	arring) arring) arring) arring) arring) departugi
ADDRE         Coli         0.0         A DDR         Appending           ADDRE         Coli         0.0         A DDR         antrong           ADDRE         Data         Data         A DDR         antrong           ADDRE         Data         Data         A DDR         antrong           ADDRE         Data         Data         A DDR         A DDR         A DDR	Aprile         7.3         7.3         0.0         A.215         apprile           ADVLM         7.51         7.51         0.0         A.216         departing           ADVLM         7.51         7.51         0.0         A.216         departing           ADVLM         7.51         1.51         0.0         A.216         departing           ADVLM         7.51         1.51         0.0         A.216         departing           00014         7.60         1.60         0.0         A.128         antrong/           AD000         7.40         1.60         0.0         A.218         antrong/           AD0000         7.40         1.60         0.00         A.218         antrong/           AD0000         7.40         1.60         1.60         1.60         1.60	_		Enterg	ency	]		00075 (2007) (2007) (2006) (2006) (2006) (2006) (2010) (2010) (2011) (2017)	442 442 142 144 144 144 144 144 144 140 140 140 141	142 142 600 600 610 626 626 627 925	649 609 600 600 600 600 600 600 600	A109 A309 A309 A309 A309 A309 A309 A309 A3	arring1 arring1 arring1 arring2 arring1 departag1 departag1
40000 20 551 0.0 A319 Argenta 40000 201 151 0.0 A519 Argenta 90014 0.00 800 0.0 A28142 arrange 400000 84 940 800 0.0 A28142 arrange 400000 840 940 940 0.0 A510 arrange	ADDE#         231         151         0.0         A.218         Appending damage           ADDE#         231         151         0.0         A.018         antronging           ADDE#         231         151         0.0         A.018         antronging           ADDE#         231         151         0.0         A.218.4         antronging           ADDE#         140         100         0.0         A.218.4         antronging           ADDE#         141         100         0.0         A.218.4         antronging           ADDE#         141         141         141         A.218.4         antronging           ADDE#         141         141         141         A.218.4         antronging	_		Enterg	ency	J		00001 420078 420064 420064 420064 420064 420103 420103 420006 420005	40 40 10 10 10 10 10 10 10 10 10 10 10 10 10	100 100 400 400 400 400 400 400 400 400	800 800 800 800 800 800 800 800 800 800	A000 A000 A000 A000 A000 A000 A000 A00	arring) arring) arring) arring) arring) departagi departagi departagi
42012 731 731 0.0 4.520 arrangi 20124 7.00 1.00 0.0 ATE-12 arrangi 42000 7.00 1.00 0.0 ATE-12 arrangi 42000 1.00 1.00 0.0 ATE-12 Arparing	dabtiji 720         121         0.0         A710         mirragi           mbitiji 700         100         0.0         A720-2         mirragi           dabnet         0.0         200         0.0         A720-2         mirragi           dabnet         0.0         200         0.0         A720-2         mirragi           dabnet         0.0         A720-2         mirragi         dabnet         0.0         A720-2         mirragi           dabnet         0.0         0.0         A720-2         dapateg         dapateg         dapateg			Enterg	ency			00001 420078 420064 420064 420064 420064 420103 420103 420006 420005	12 12 12 12 12 12 12 12 12 12 12 12 12 1	100 100 400 400 400 400 400 400 400 400	848 849 840 840 840 840 840 840 840 840 840 840	A000 A000 A000 A000 A000 A000 A000 A00	armegt armegt armegt armegt departagt departagt departagt departagt departagt
80014 0.00 R00 0.0 ATR-42 series 400000 0.0 R00 0.0 ATR-42 series 400000 0.0 R00 0.0 ATR-42 series	000134 190 100 0.0 ATR-42 armsgr Added 140 200 0.0 A-110 armsgr Admin 21 210 0.0 A-110 armsgr Admin 21 210 0.0 A-110 departing	_		Enterg	ency			423078 423078 423064 423064 423064 423064 423064 423064 423064 423064		100 100 600 610 610 610 610 610 710 710 710	500 500 500 500 500 500 500 500 500 500	A318 A318 A318 A318 A318 A318 A318 A318	armegt armegt armegt armegt departagt departagt departagt departagt departagt
80014 0.00 R00 0.0 ATR-42 series 400000 0.0 R00 0.0 ATR-42 series 400000 0.0 R00 0.0 ATR-42 series	000134 190 100 0.0 ATR-42 armsgr Added 140 200 0.0 A-110 armsgr Admin 21 210 0.0 A-110 armsgr Admin 21 210 0.0 A-110 departing			Enterg	ency			0001 02012 42564 42584 42584 42584 42584 42584 42584 42584 42584 42594 42594	12 12 12 12 12 12 12 12 12 12 12 12 12 1	100 100 600 610 610 610 610 610 710 710 710	500 500 500 500 500 500 500 500 500 500	A318 A318 A318 A318 A318 A318 A318 A318	armegt armegt armegt armegt departagt departagt departagt departagt departagt departagt
Addition allo and AVE-4C Apparing	ADDER BIT BES D.D. ATR-C. Apparing ADDER BIT BES D.D. ATR-C. Apparing			Emerg <del>N</del>	ency			00014 420478 42049 42049 42049 42049 42049 42049 42009 42009 42009	12 12 12 12 12 12 12 12 12 12 12 12 12 1	100 100 600 610 610 610 610 710 710 710 710	5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	A318 A318 A318 A318 A318 A318 A318 A318	arregi arregi arregi arregi departagi departagi departagi departagi departagi departagi departagi departagi departagi departagi
ADDE DI	ADDER BIT BES D.D. ATT-C. Apparing ADDER BIT BES D.D. ATT-C. Apparing ADDER BIT BES D.D. ATT-C. Apparing			Enterg X	ency			420078 420078 420096 420096 420096 420096 420090 420090 420090 420090 420090 420090 420090		100 100 000 010 010 010 010 010	5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	A318 A318 A318 A318 A318 A318 A318 A318	arring1 arring2 arring2 arring3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3
	ADDIT RTD RTD DO ADDIT DESIDE			Enterg	ency			00076 420978 42099 42099 42099 42099 42099 42099 42099 42099 42019 42019 42019 42019	12 年12 月 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日	1.00 1.00 1.00 4.00 4.00 4.00 4.00 7.00 7.00 7.00 7.00 7.00 7.00 7.00 7.00 7.00 7.00 7.00 7.00 7.00 8.00 8.00 7.00 7.00 8.00 7.00	5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	A309 A308 A308 A309 A309 A309 A309 A309 A309 A309 A309	arring1 arring2 arring2 arring3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 arring3 arring3
				Energ X	ency			420978 422959 422959 422959 422959 422959 422959 422059 422059 422259 422259 422259 422259 422259 422259 422259 422259 422259 422259	12 年11 日日 日日 日日 日日 日日 日日 日日 日日 日日 日日 日日 日日 日日		5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	A-210 A-210	arring1 arring2 arring2 arring3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 departag3 arring3 arring3

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.

#### V. ACKNOWLEDGEMENT

It is a privilege to express sincerest regards to, Dr. R. C. Jaiswal, for his valuable inputs, guidance, encouragement, whole-hearted cooperation and constructive criticism throughout the duration of the research work.

Under Professor Jaiswal's guidance I was able to present my work on the topic "Dynamic Runway and Gate terminal Allocation for flights" at the department premises before NAAC(national accreditation and assessment council). I would take this opportunity to thank all my lecturers who have directly or indirectly helped in this work.

I pay my respect and love to parents and all other family members and friends for their love and encouragement throughout my career and express thanks to my friends for their cooperation and support.

#### **VI. REFERENCES**

- "Project Scheduling with Time Windows: From Theory to Application", by Ulrich Dorndorf, A springer Verlag company, Heidelberg, New York: Physica-Verl, 2002, pp109-136.
- Book: Java- The Complete Reference by Herbert Schildt Seventh edition; McGraw Hill education (India) Private Ltd, New Delhi, Dec. 2006.
- [3] "The Value of Runway Time Slots For Airlines", by Jia-Ming Cao and Adib Kanafani, Institute of transportation studies University of California at working paper UCB-ITS-WP-97-2,May 1997,Berkeley,USA.
- [4] "Airline fleet assignment concepts, models, and algorithms" by Hanif Sherali, Ebru Bish, Xiaomei Zhu, Science direct Trans. European Journal of operational research 172(2006), pp 1-30, April 2005.
- [5] "Algorithm Design: Greedy algorithm", by Jhon Kleinberg and Eva Tardos Chapter 4, Sildes by Kevin Wayne, pp 1-40, May 2005.
- [6] "Runway Occupancy Time As Element Of Runway Capicity", by Stanislav Pavlin, Mario Zuzic and Stipe Pavicic, Transport and traffic science, May 2006, Zagreb, Republic of Croatia.
- [7] Doug Stewart, "Aviation data management system": https/://www.aircraftlogs.com/Platform/Scheduling.

- [8] IEEE paper by Chris Brinton ; Stephen Atkins ; Lara Cook ; Steven Lent ; Tom Prevost on "Ration by Schedule for airport arrival and departure planning and scheduling" Published in: 2010 Integrated Communications, Navigation, and Surveillance Conference Proceedings.
- [9] R. A. DeLaura, R. F. Ferris, F. M. Robasky, S. W. Troxel, and N. K. Underhill, "Initial assessment of wind forecasts for Airport Acceptance Rate (AAR) and Ground Delay Program (GDP) planning," Lincoln Laboratory, Tech. Rep. ATC-414, January 2014.
- [10] Federal Aviation Administration, "Aviation System Performance Metrics (ASPM) database." [Online]. Available: aspm.faa.gov
- [11] Federal Aviation Administration, "Airport capacity benchmark report," 2004.
- [12] P.-C. B. Liu, M. Hansen, and A. Mukherjee, "Scenario based air traffic flow management: From theory to practice," Transportation Research Part B, vol. 42, pp. 685–702, 2008.
- [13] Flight Transportation Associates, "Enhanced Preferential Runway Advisory System (ENPRAS)." [Online]. Available: <u>http://www.ftausa.com/enpras.html</u>
- [14] Book: Introduction to Algorithms by Cormen, Rivest and Stein, THIRD EDITION Section:4 Advanced Design and Analysis Techniques Chapter 16: greedy algorithms
- [15] Book: "Design and Analysis of Computer Algorithms" by Alfred V. Aho and John E. Hocroft Chapter 10: Algorithm Design Techniques

