1. The implementation

   1.1 Environment

   Here we have the Initial data:

   5 airports, 5/10 airplanes, record time:500/1000(hr);

   a two-dimension matrix to represent the distance between each pair of airports. These distances are initialized by distributing random values between 5000-9999.

   1.2 Queuing system

   Every airport maintains a maxheap. I only push ARRIVED and DEPARTURE events into these queues. I set an attribute “queueTime” in the airportEvent. The maxHeap’s order is based on this attribute. As there is no given information about the takeoff time of the DEPARTURE, I assume the takeoffs in DEPARTURE take no time duration but one time spot. So the “queueTime” will equals the end time of ARRIVED event or start time(point) of DEPARTURE event.

   When we will decide the end time of the ARRIVED or DEPARTURE event. We will pick the MAX(currentTime, PeekTime of MaxHeap) + lasting time of the event to calculate the end time. If PeekTime of MaxHeap is larger than currentTime, then the difference will be the circling time for this ARRIVING event.

   Every time the global Treeset pull out event, the matched Airport Queuing System will also remove the event.

   Below is a decision tree every time we schedule an event.

2.
```
/**
 * Decision Tree:
 *     1. Is it Airport Event or Stopping Event? If Airport Go to 2,
else go to 8.
 *     2. Is it LANDING/DEPARTING event?  If Yes go to 3, else go to
8.
 *     3. Is this Airport Queuing System Empty? If No go to 4, else go
to 5 and 8.
 *     4. Event End time = Max(Queue.peek, currentTime)+ lastingTime.
Go to 5.
 *     5. Insert the event into the Airport Queuing System. LANDING or
DEPARTING? if Landing go 6, else go 7.
 *     6. Queuing time is the same as the end time.
 *     7. Queuing time is the same as the start time.
 *     8. Set the end time = start time + lasting time.
 */
```

1.3 Destination

I keep an index for every airport. And pass the distance matrix to every airport. Every time to schedule a depart event, it will randomly pick an index which is different from the index itself to find the destination and distance.

2. Future work

2.1 CurrentTime

This is not a real time system. It uses last event ending time as the current time which does not fit the real situation.

2.2 MaxHeap or an array

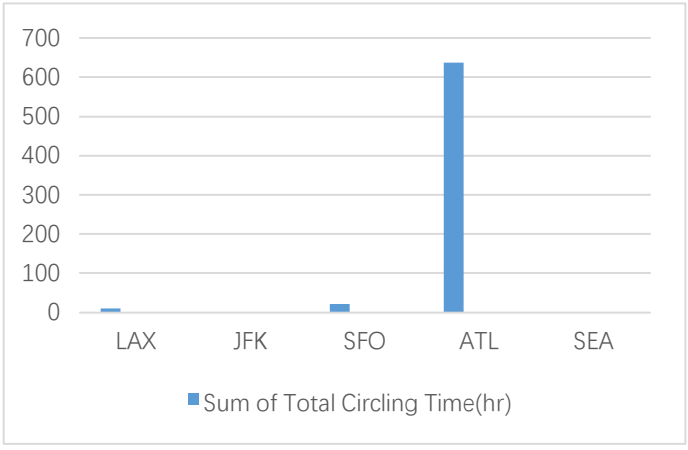
The logic in my algorithm is to use max heap to keep the largest time which has been scheduled for arriving or leaving. And the time before this largest time point can't work. But it is really possible that you can insert new event between two scheduled event. But that involves maintaining an array and searching the array(O(n) time complexity.) So one option is wasting time which could be used for new events, another one is time complexity consuming on finding new time spot for new event. In the future I need to implement the array option and balance two options in different situations.

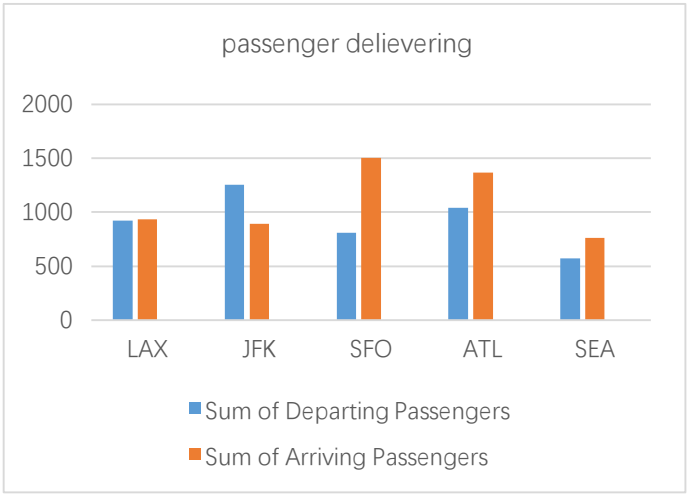
3. Results

3.1 Comparison Charts

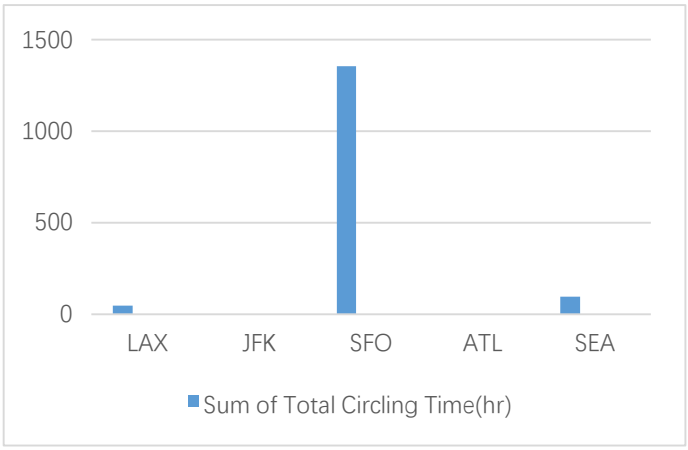
Below is the chart showing comparison of results of different input.

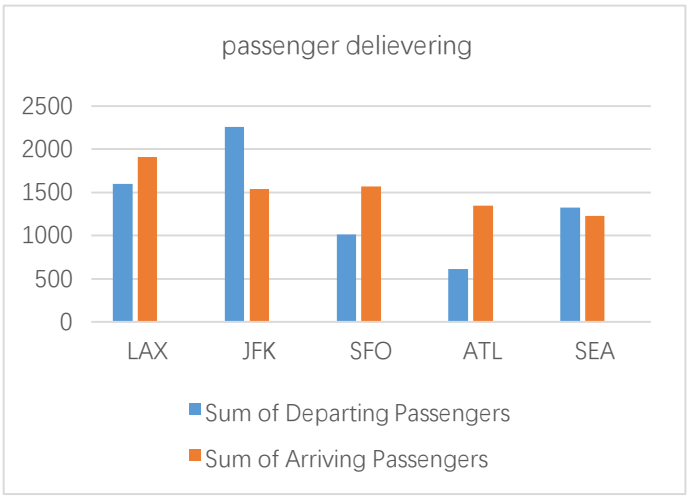
1) Input (5 airports, 5 planes, 500hrs)



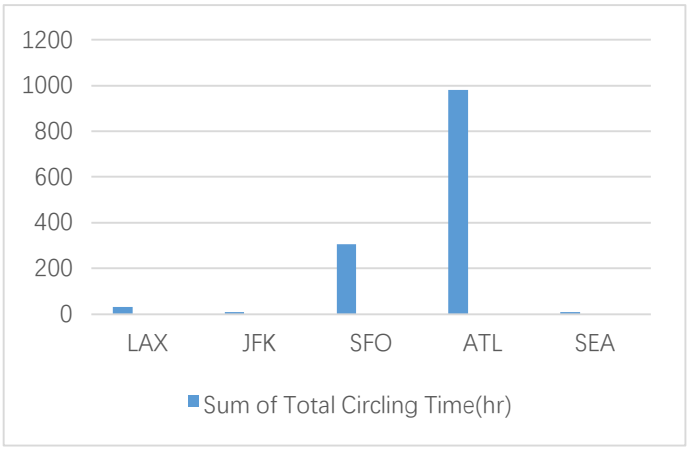


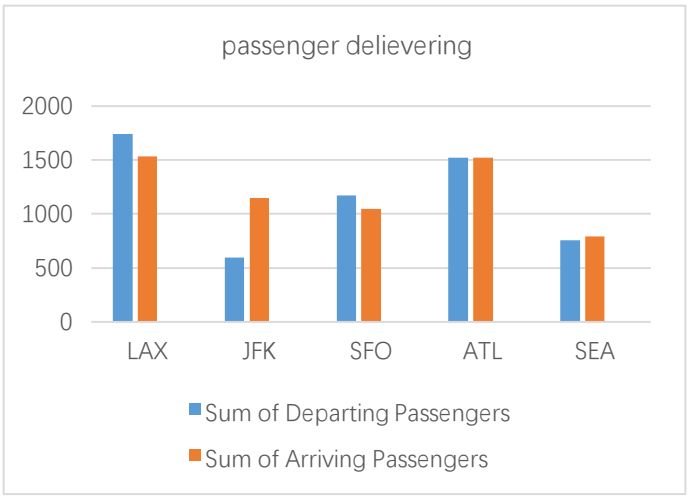
2) Input (5 airports, 5 planes, 1000hrs)



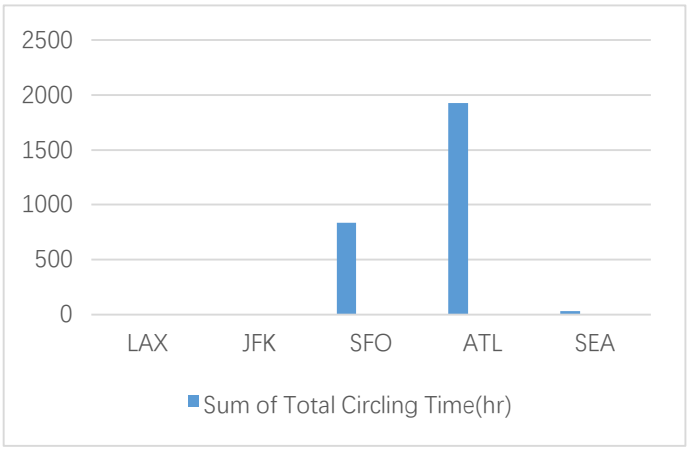


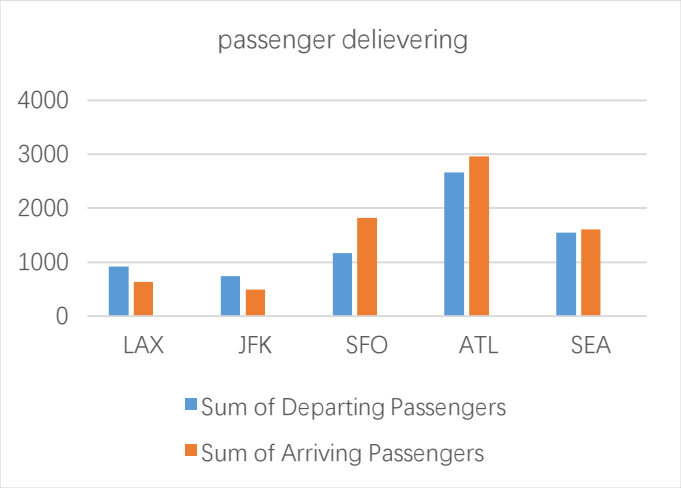
3) Input (5 airports, 10 planes, 500hrs)





4) Input (5 airports, 10 planes, 1000hrs)





3.2 Raw Data Sample

As the raw result is so long, here I only include result list of (5 airports, 10 airplanes, 500hr) input:

0.0: Plane A0 arrived at Airport LAX
Planned circling time is 0.0
0.0: Plane A1 arrived at Airport JFK
Planned circling time is 0.0
0.0: Plane A2 arrived at Airport SFO
Planned circling time is 0.0
0.0: Plane A3 arrived at Airport ATL
Planned circling time is 0.0
0.0: Plane A4 arrived at Airport SEA
Planned circling time is 0.0
0.0: Plane A5 lands at airport LAX
0 passangers are arriving
0.0: Plane A6 lands at airport JFK
0 passangers are arriving
0.0: Plane A7 lands at airport SFO
0 passangers are arriving
0.0: Plane A8 lands at airport ATL
0 passangers are arriving
0.0: Plane A9 lands at airport SEA
0 passangers are arriving
0.3: Plane A0 lands at airport LAX
150 passangers are arriving
0.3: Plane A1 lands at airport JFK
222 passangers are arriving
0.3: Plane A2 lands at airport SFO
345 passangers are arriving
0.3: Plane A3 lands at airport ATL

210 passangers are arriving
0.5: Plane A4 lands at airport SEA
300 passangers are arriving
2.0: Plane A5 departs from airport LAX
157 passangers are departing
2.0: Plane A7 departs from airport SFO
31 passangers are departing
2.0: Plane A9 departs from airport SEA
52 passangers are departing
2.3: Plane A0 departs from airport LAX
90 passangers are departing
2.3: Plane A2 departs from airport SFO
329 passangers are departing
2.5: Plane A4 departs from airport SEA
60 passangers are departing
3.0: Plane A6 departs from airport JFK
21 passangers are departing
3.0: Plane A8 departs from airport ATL
86 passangers are departing
3.3: Plane A1 departs from airport JFK
162 passangers are departing
3.3: Plane A3 departs from airport ATL
236 passangers are departing
9.0: Plane A7 arrived at Airport SEA
Planned circling time is 0.0
9.5: Plane A7 lands at airport SEA
31 passangers are arriving
10.0: Plane A5 arrived at Airport ATL
Planned circling time is 0.0
10.0: Plane A9 arrived at Airport SFO
Planned circling time is 0.0
10.3: Plane A0 arrived at Airport JFK
Planned circling time is 0.0
10.3: Plane A2 arrived at Airport LAX
Planned circling time is 0.0
10.3: Plane A5 lands at airport ATL
157 passangers are arriving
10.3: Plane A9 lands at airport SFO
52 passangers are arriving
10.600000000000001: Plane A0 lands at airport JFK
90 passangers are arriving
10.600000000000001: Plane A2 lands at airport LAX
329 passangers are arriving
12.3: Plane A9 departs from airport SFO

0 passangers are departing
12.600000000000001: Plane A2 departs from airport LAX
199 passangers are departing
21.0: Plane A4 arrived at Airport ATL
Planned circling time is 9.5
21.3: Plane A4 lands at airport ATL
60 passangers are arriving
21.6: Plane A3 arrived at Airport JFK
Planned circling time is 9.3
21.900000000000002: Plane A3 lands at airport JFK
236 passangers are arriving
22.0: Plane A8 arrived at Airport SEA
Planned circling time is 8.0
22.5: Plane A8 lands at airport SEA
86 passangers are arriving
24.5: Plane A8 departs from airport SEA
26 passangers are departing
24.900000000000002: Plane A3 departs from airport JFK
84 passangers are departing
27.0: Plane A7 departs from airport SEA
119 passangers are departing
27.900000000000002: Plane A0 departs from airport JFK
113 passangers are departing
31.5: Plane A6 arrived at Airport ATL
Planned circling time is 20.5
31.8: Plane A6 lands at airport ATL
21 passangers are arriving
32.5: Plane A8 arrived at Airport LAX
Planned circling time is 0.0
32.8: Plane A8 lands at airport LAX
26 passangers are arriving
34.0: Plane A7 arrived at Airport SFO
Planned circling time is 0.0
34.3: Plane A7 lands at airport SFO
119 passangers are arriving
42.5: Plane A1 arrived at Airport ATL
Planned circling time is 31.2
42.8: Plane A1 lands at airport ATL
162 passangers are arriving
48.8: Plane A5 departs from airport ATL
175 passangers are departing
52.8: Plane A9 arrived at Airport ATL
Planned circling time is 33.5
53.099999999999994: Plane A9 lands at airport ATL

0 passangers are arriving
56.8: Plane A5 arrived at Airport SEA
Planned circling time is 0.0
57.3: Plane A5 lands at airport SEA
175 passangers are arriving
59.3: Plane A5 departs from airport SEA
107 passangers are departing
64.0: Plane A3 arrived at Airport LAX
Planned circling time is 32.099999999999994
64.3: Plane A3 lands at airport LAX
84 passangers are arriving
66.3: Plane A3 departs from airport LAX
15 passangers are departing
73.0: Plane A0 arrived at Airport SFO
Planned circling time is 33.099999999999994
73.3: Plane A3 arrived at Airport SEA
Planned circling time is 0.0
73.3: Plane A0 lands at airport SFO
113 passangers are arriving
73.8: Plane A3 lands at airport SEA
15 passangers are arriving
74.1: Plane A2 arrived at Airport ATL
Planned circling time is 52.49999999999999
74.39999999999999: Plane A2 lands at airport ATL
199 passangers are arriving
75.3: Plane A0 departs from airport SFO
143 passangers are departing
75.8: Plane A3 departs from airport SEA
148 passangers are departing
82.8: Plane A3 arrived at Airport LAX
Planned circling time is 0.0
83.1: Plane A3 lands at airport LAX
148 passangers are arriving
85.1: Plane A3 departs from airport LAX
162 passangers are departing
89.69999999999999: Plane A4 departs from airport ATL
120 passangers are departing
89.69999999999999: Plane A6 departs from airport ATL
391 passangers are departing
89.69999999999999: Plane A1 departs from airport ATL
49 passangers are departing
89.69999999999999: Plane A9 departs from airport ATL
188 passangers are departing
90.9: Plane A8 departs from airport LAX

216 passangers are departing
94.69999999999999: Plane A5 arrived at Airport ATL
Planned circling time is 27.39999999999999
94.99999999999999: Plane A5 lands at airport ATL
107 passangers are arriving
96.69999999999999: Plane A1 arrived at Airport SFO
Planned circling time is 0.0
96.99999999999999: Plane A1 lands at airport SFO
49 passangers are arriving
97.69999999999999: Plane A6 arrived at Airport JFK
Planned circling time is 0.0
97.99999999999999: Plane A6 lands at airport JFK
391 passangers are arriving
98.69999999999999: Plane A4 arrived at Airport LAX
Planned circling time is 0.0
98.99999999999999: Plane A4 lands at airport LAX
120 passangers are arriving
99.69999999999999: Plane A9 arrived at Airport SEA
Planned circling time is 0.0
100.19999999999999: Plane A9 lands at airport SEA
188 passangers are arriving
100.99999999999999: Plane A6 departs from airport JFK
21 passangers are departing
100.99999999999999: Plane A4 departs from airport LAX
281 passangers are departing
102.19999999999999: Plane A9 departs from airport SEA
244 passangers are departing
102.9: Plane A7 departs from airport SFO
304 passangers are departing
109.19999999999999: Plane A9 arrived at Airport LAX
Planned circling time is 0.0
109.49999999999999: Plane A9 lands at airport LAX
244 passangers are arriving
111.49999999999999: Plane A9 departs from airport LAX
107 passangers are departing
157.0: Plane A2 departs from airport ATL
165 passangers are departing
163.0: Plane A0 arrived at Airport ATL
Planned circling time is 78.7
163.3: Plane A0 lands at airport ATL
143 passangers are arriving
166.0: Plane A2 arrived at Airport LAX
Planned circling time is 0.0
166.3: Plane A2 lands at airport LAX

165 passangers are arriving
168.3: Plane A2 departs from airport LAX
179 passangers are departing
197.39999999999998: Plane A8 arrived at Airport SFO
Planned circling time is 95.49999999999997
197.7: Plane A8 lands at airport SFO
216 passangers are arriving
248.3: Plane A3 arrived at Airport ATL
Planned circling time is 153.20000000000002
248.60000000000002: Plane A3 lands at airport ATL
162 passangers are arriving
290.29999999999995: Plane A1 departs from airport SFO
100 passangers are departing
297.29999999999995: Plane A9 arrived at Airport SFO
Planned circling time is 176.79999999999995
297.59999999999997: Plane A9 lands at airport SFO
107 passangers are arriving
299.59999999999997: Plane A9 departs from airport SFO
62 passangers are departing
300.29999999999995: Plane A1 arrived at Airport JFK
Planned circling time is 0.0
300.59999999999997: Plane A1 lands at airport JFK
100 passangers are arriving
303.59999999999997: Plane A1 departs from airport JFK
49 passangers are departing
308.59999999999997: Plane A9 arrived at Airport LAX
Planned circling time is 0.0
308.9: Plane A9 lands at airport LAX
62 passangers are arriving
310.9: Plane A9 departs from airport LAX
105 passangers are departing
313.59999999999997: Plane A1 arrived at Airport SFO
Planned circling time is 0.0
313.9: Plane A1 lands at airport SFO
49 passangers are arriving
336.4: Plane A5 departs from airport ATL
109 passangers are departing
341.4: Plane A6 arrived at Airport ATL
Planned circling time is 232.39999999999998
341.7: Plane A6 lands at airport ATL
21 passangers are arriving
343.4: Plane A5 arrived at Airport JFK
Planned circling time is 0.0
343.7: Plane A5 lands at airport JFK

109 passangers are arriving
346.7: Plane A5 departs from airport JFK
149 passangers are departing
410.79999999999995: Plane A8 departs from airport SFO
203 passangers are departing
421.79999999999995: Plane A8 arrived at Airport LAX
Planned circling time is 0.0
422.09999999999997: Plane A8 lands at airport LAX
203 passangers are arriving
424.09999999999997: Plane A8 departs from airport LAX
227 passangers are departing
451.4: Plane A4 arrived at Airport ATL
Planned circling time is 341.4
451.7: Plane A4 lands at airport ATL
281 passangers are arriving
Simulator stopping at time: 500.0
LAX total circling Time: 32.099999999999994
LAX total departing passengers: 1738
LAX total arriving passengers: 1531

JFK total circling Time: 9.3
JFK total departing passengers: 599
JFK total arriving passengers: 1148

SFO total circling Time: 305.3999999999999
SFO total departing passengers: 1172
SFO total arriving passengers: 1050

ATL total circling Time: 980.3
ATL total departing passengers: 1519
ATL total arriving passengers: 1523

SEA total circling Time: 8.0
SEA total departing passengers: 756
SEA total arriving passengers: 795