CEE 5614: Analysis of Air Transportation Systems Spring 2018

Final Graduation Exercise

Date Due: May 7, 2018 (via email in PDF form) Instructor: Trani

Groups of 2 students allowed

Include a brief writeup of the answers and explain your solution

Include the Excel or Matlab file used to solve the problem

Send me the Excel or Matlab scripts for review

Problem 1

Solve an updated version of the Airline Scheduling Problem (ASP-1) explained in class with the following characteristics. The airline now is evaluating the purchase of new generation regional aircraft (i.e., CRJ-700 and EMB-190) to operate out of DCA. The new airline wants to operate in the markets shown in Table 1. The following aircraft are potential contenders for possible use by the airline.

a) Find the typical block times (i.e., time from gate to gate) for each aircraft type using the NAS operations file provided (called **nasOperations_file.xls**). Consider the actual distances flown in your assessment of block times. The file contains departure and arrival times for flights in the NAS recorded in a typical day. Add 10 minutes to account for taxi in and 7 minutes for taxi out to each flight at airports to account for times on the ground to reach a gate.

b) Maximize profit solving for the fleet size and frequency assignment **without a minimum frequency constraint**. Clearly state the number of aircraft of each type needed (use an **integer solution**) and the number of flights between each origin-destination pair to satisfy the two basic constraints (demand and supply constraints). Use Excel Solver or the Matlab optimization toolbox to solve the problem.

c) Calculate the fares to be charged in each O-D pair if the airline wants to recover its full cost for service plus a 10% profit. In your calculation assume the hourly operating cost of the aircraft shown in Table 1 is 70% of the total operating cost of the carrier. That is, 30% of the cost of running is due to administrative and other costs not related to operation of the aircraft.

d) Comment your assessment of the economics of using new generation regional jets such as the Bombardiers CRJ-900 and the Embraer 190 in the proposed routes.

All other parameters of the model are the same as ASP-1.

Table 1. Aircraft Operating Cost and Performance. Data source: Bureau of Transportation Statistics (2017).

Aircraft	Bombardier CRJ-900	Embraer EMB-190	Boeing 737-700	Airbus A319
Name of Aircraft in the NAS Operation File	CRJ9	E190	B737	A319
Seats	84	86	132	128
Block Speed (knots)	To be derived from data set provided			
Operating Cost ($/hr)	3,980	4,140	5,235	5,160
Typical maximum aircraft utilization (hrs/day) in service	12.5	12.5	12.7	12.6

Table 2. OD Markets for the Proposed New Airline.

Origin-Destination Airports	Daily Demand (passengers)
DCA-ATL	430
ATL-DCA	490
DCA-LAS	210
LAS-DCA	200
DCA-BOS	320

Origin-Destination Airports	Daily Demand (passengers)
BOS-DCA	310
DCA-DFW	165
DFW-DCA	173
DCA-LGA	400
LGA-DCA	380
DCA-MDW	280
MDW-DCA	265

Problem 2

An airline would like to schedule four flights between DCA and ATL to minimize the passenger schedule delay. Surveys done in Atlanta show that travelers would like to travel at times indicated by the demand function curve shown in Figure 2.

Time = [0 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24];

CumulativeDemand =[0 0 0.074 0.186 0.29 0.36 0.38 0.39 0.41 0.44 0.47 0.53 0.59 0.67 0.77 0.87 0.93 0.96 0.99 1 1 1 1]

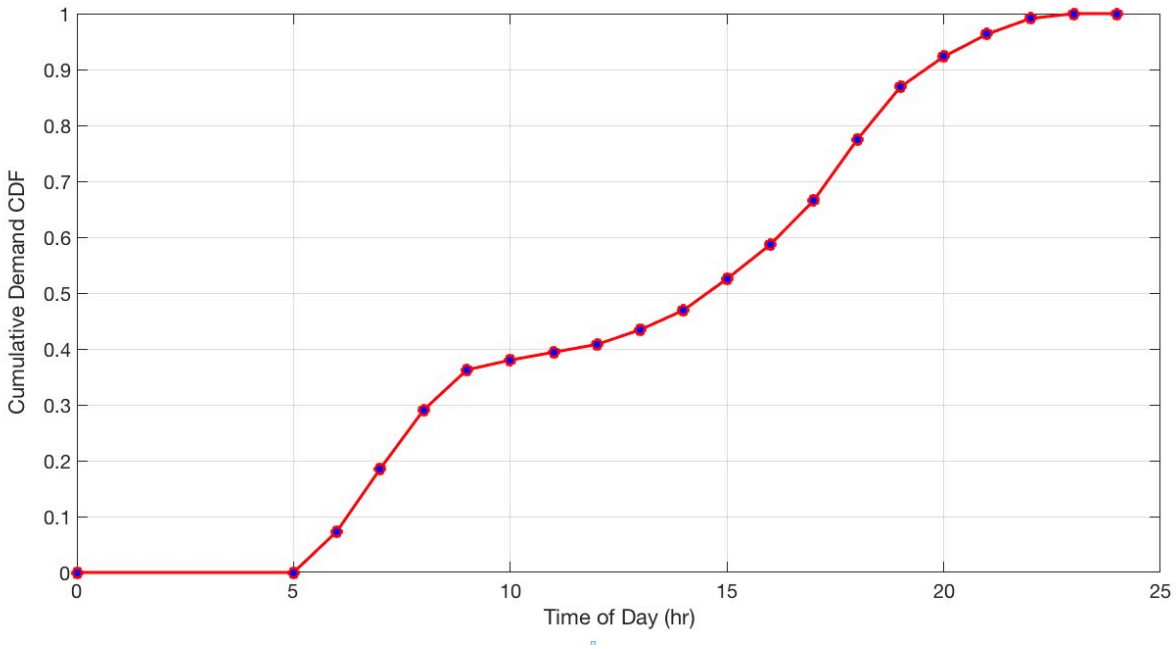

Figure 2. Cumulative Demand function for Problem 2.

Use the aircraft selected in Problem 1 to fly this route to answer the following questions.
a) Find the optimal departure times for the flights assigned to the route to minimize the schedule delay to passengers. The schedule delay is defined as the time difference between each traveler's departure time and the time when the airline offers a flight. Show all your calculations.
b) Calculate the total delay for all passengers flying between DCA and ATL.
c)

Problem 3

For the optimal solution found in Problem 1, find the minimum (i.e., optimal) number of crews to run this small airline. To simplify the problem consider the following:

a) Each crew is made of two pilots for all the aircraft
b) Per typical FAA regulations, aircraft crews can work up to 12 hours of duty time and up to 8 hours of actual flight time (these limit the number of flights per rotation a crew is allowed to fly in a day).
c) Just focus on estimating the crews needed for one typical day
d) Make sure all flights are covered by at least one crew
e) if a crew stays overnight away from DCA, the cost is $4,000 otherwise assume a cost of $3,000

This problem can be solved using optimization (see crew scheduling problem discussed in class) or using other heuristic methods such as simple mathematical estimations of resources needed.