

Assignment 4: Air Transportation Systems Analysis

Solution

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Problem 1

The National Airspace System is a complex system with thousands of commercial flights each day. The file nasOperations_2011.xls contains a sample of the flights that happened one day in the NAS in the year 2011. The header and a few flights are illustrated in Table 1. The Excel file contains a tab that explains each one of the columns of data (see Data Dictionary Tab).

Table 1. Sample NAS Flights File.

Flight ID	Aircraft Type	Type of Aircraft	Origin Airport	Destination Airport	Cruise Flight Level (feet/100)	Cruise Speed (knots)	Departure Time (hrs)	Arrival Time (hrs)	Distance Flown (nm)
BSK641	B738	J	MUHA	MIA	230	346	1.70	3.40	235.17
CSDKC	GLF5	J	OMA	DAL	190	337	13.83	16.15	586.62
EJA931	C750	J	FLL	APF	60	249	23.50	0.12	100.82
TSU132	CVLT	T	MDSO	BQN	150	279	23.63	0.40	166.49
ABX2217	B762	J	MIA	SPIM	340	471	22.78	4.55	2621.49
ABX2250	DC86	J	NGU	MUGM	320	450	12.13	15.20	1178.55
ABX2251	DC86	J	MUGM	NGU	380	453	17.18	20.77	1178.55
ABX38	B762	J	ZBAA	ANC	390	462	19.28	3.25	3950.40
AIP511	B190	T	HNL	MUE	130	219	11.30	12.32	171.82
AIP512	B190	T	MUE	HNL	120	219	12.63	13.65	171.82

- a) Examine operations in the NAS performed by the new generation of Boeing 737 family aircraft (models B737, B738 and B739 in column 2). Make a histogram of cruise flight levels assigned to the aircraft stated above and observe if there is any correlation between cruise altitude and distance flown. Explain the trends observed.

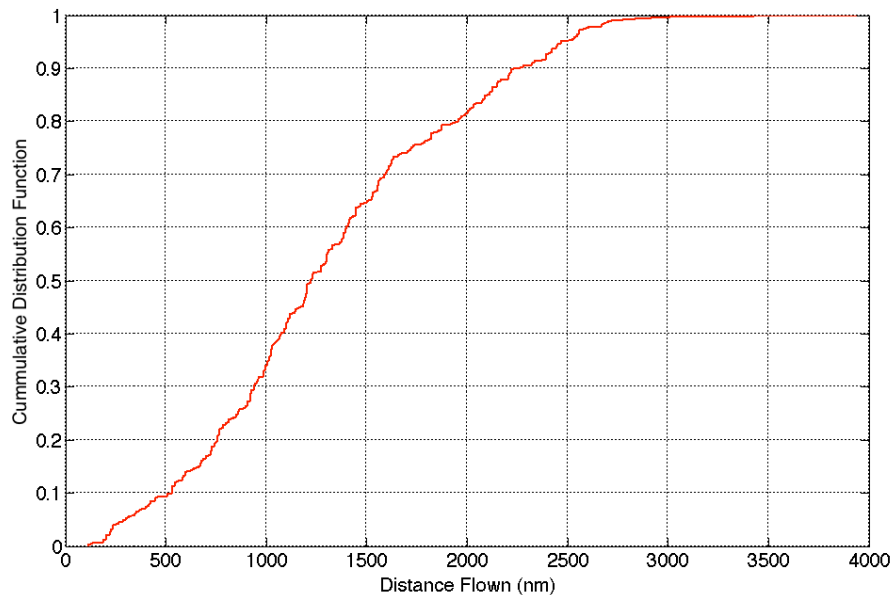


Figure 1. CDF of Distance Flown Levels for Boeing 737-800. Stage Length is 1,318 nm average.

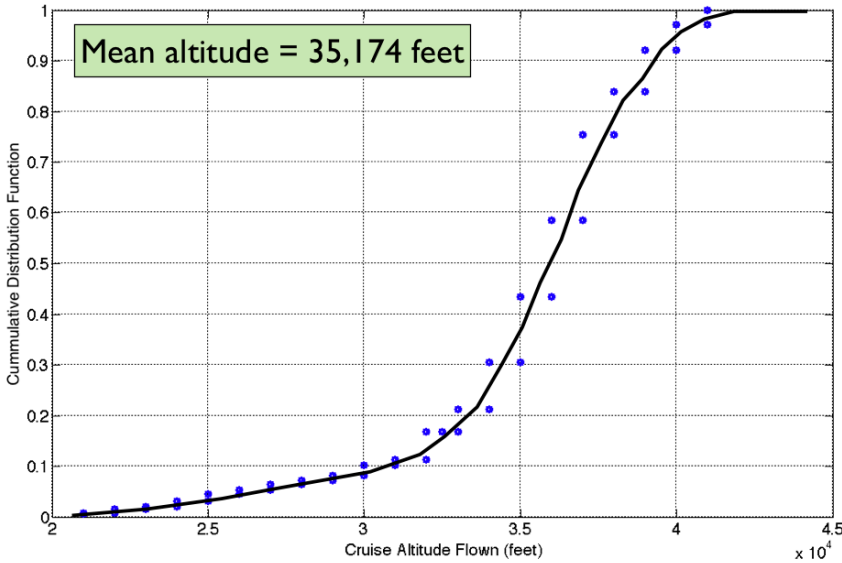


Figure 2. CDF Plot of Cruise Altitude Flown by Boeing 737-800 Aircraft. Mean Altitude is 35,174 feet.

- b) For the aircraft fund in Part (a), create a histogram representing the stage length flown by the aircraft vs frequency of operations.
- c) Compare daily operations of Southwest Airlines (flight ID starts with SWA) Boeing 737 and those of United Airlines (flight ID starts with UAL) in the NAS. Contrast the distribution of the stage lengths flown (i.e., distance flown) and the cruise flight levels and filed cruise speeds used.

The distribution of flight levels for the two airlines look different. This problem requires that you study similar aircraft types within one family. For example, Southwest Airlines has Boeing 737-700 (B737) , 737-300 (B733) and 737-500 (B735). United mostly has B735 and B733 aircraft.

Table 1. Boeing 737-500 Data.

Airline	Speed (knots)	Cruise Altitude (ft)	Distance (nm)
SWA	429	32,091	223
UA	430	34,762	862

Doing a statistical test, SWA and United cruise at different altitudes. Note that the key is the average distance flown. UNited employs the B735 fleet in longer stage lengths. Hence a higher cruise altitude.

- d) Filter all Boeing 777 aircraft in the data set (models B772 and B773 in column 2) and explain the types of routes flown by these aircraft compared to the analysis done in part (a). Does the B777 flies faster (statistically speaking) than the Boeing 737? Explain.

The Boeing 737 fleet (just Boeing 737-700) is flown at 443 knots average (standard deviation is 14.1 knots). The Boeing 777-200 is flown at an average speed of 480 knots (std. deviation of 10.7 knots). Doing a statistical analysis comparing the means we conclude their average speeds are very different.

Problem 3

- a) For the new generation long-range transport aircraft provided in the class web site (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing787_class.m), estimate climb profile (distance vs. altitude) using the `unrestrictedClimbAnalysis.m` Matlab script. Run the program at the aircraft MTOW.
- b) How many metric tons of fuel does the aircraft burns in the climb profile to 35,000 feet.
- c) What distance is covered during the climb to 35,000 feet?
- d) Repeat the process (parts a-c) for ISA + 30 degree conditions. You control the temperature profile changing line 44 of `UnrestrictedClimbAnalysis.m`. Using a `deltaTemp` value of 30 degree (positive) the computer program will use ISA + 30 degrees of temperature. Comment on the differences observed.

```
deltaTemp = 0;           % ISA + deltaTemp conditions for analysis (deg. Kelvin)
```

Condition	Climb Fuel (kg)	Distance (nm)
ISA	4,183	129
ISA + 30	5,187	197