Assignment2

AE4423 – Airline Planning & Optimization 2019/2020

Introduction

In this 2nd assignment, you will start a new job at thecargo division of your Airline. This is a new unit of your airline that is starting operations in the next quarter of the year. Your first task is to design the flight schedule and the aircraft routings for your operations, to maximize the profits. Thechosen business model is to transport cargoovernight with fully dedicated second-hand freight aircraft that your airline has.

For this assignment, consider the network given in the 1st assignment with 20 airports and the location of your hub airport. For the demand matrix, aircraft data, costs, and revenue you will use new input data.

Read the assignment carefully (including the appendices) to extract all information required to adapt the model presented in the lecture!

Aircraft Routing Problem

Timetable development&aircraft routing

With the input data available in the Excel file supplied with the assignment and the Appendix, determine the flight schedule and aircraft routing fora period of fivedays (120-hour period). That is, you have to determine which aircraft to fly a specific route as well as the departure time of each flight. Assume that all your aircraft must start and end the period of five days at your hub airport and that only flights to and from the hub are considered (i.e., you are not considering spoke-to-spoke flights). The goal is to maximize the profit over this period.

To achieve this goal, you need to:

1. Apply the dynamic programming frameworkpresented during the lectures to solve the problem.
2. Setup a **computer model** (e.g., in Python or Matlab) according to the dynamic programming framework. You should not use any commercial solver.
    - Write in your assignment the pseudo-code of your computer model.
3. Determine the optimal routing of each aircraft and corresponding departure times, assuming:
    - the data in the Excel file (airport list, demand matrix and fleet information);
    - and the data in the appendices from this assignment (aircraft routes to consider, demand management, revenue, costs). Note that you can reuse part of the input data from Assignment 1, such as the airport data.

General information

- **Motivate your choices, comment on results, and be critical towards results!**
- Describe the dynamic programming model, your assumptions, results and KPIs in detail in a comprehensive report of **no more than10 pages A4** (excluding cover but including appendixes; font equivalent toTimes New Roman – 12 pt, line spacing 1.15 and standard margins).**Note that the report shall not contain any computer code.**
- Use **figures** and **tables** to present your results and KPIs and support your conclusions.
- Submit your report and model script file(s) through **BrightSpace** (assignment folder in our course webpage) at the **latest on Tuesday 12January, 18.00 hrs**. Don't forget to include the group number, names and student IDs in the report (and script file(s)). Do **NOT** submit input (Excel) files. Files submitted by email will not be considered.
- **If you fail to meet the deadline**, 0.5 points will be deducted from your grade for **each day** after the deadline. No excuses will be accepted! Make sure that you work as a group and save the latest versions of your work in multiple places.
- All files uploaded in BrightSpace should be uploaded as **individual files** (i.e., not compressed as '.zip', '.tar',…) to be subjected to **Turnitin check**. **If compressed files are uploaded**, 1.0 points will be deducted from your grade.
- **If you fail to obtain a grade of 5.5 or higher you will fail the assignment.** In that case, you will get a chance to improve your work and pass the assignment. Your final grade cannot become higher than 6.0 in that case.
- You should include a separate overview of the **workload distribution** of each group member. Indicate (in percentages) each member's contribution to the three categories **modelling framework (30%)**, **programming (50%)**and **reporting (20%)**. Based on this overview you will receive an individualized grade for the assignment. For an example of the format see Appendix E.
- **An assessment matrix** will be available to clarify the grading process.

Appendices

A. Aircraft routes to consider

Your airline will only consider adding aircraft routes that:

- Are profitable – i.e., you do not have to use all aircraft in your fleet;
- Respect range and runway constraints.

B. Demand management

1. The demand is given in 4-hour bins. The input Excel file shows the demand associated with each 4-hour bin. Observe that demand only occurs from 8pm until 8am.

Note:

- the demand is given per route and they already consider the connection of cargo at the hub;
- demand for a 4-hour bin will be available at any time within this 4-hour bin.

2. When you fly at hour *t*, you can assume that you can capture all the demand of the associated 4-hour bin and a maximum of 20% of the demand associated with the two previous 4-hour bins (so earlier during the **same night**). In other words, if your flight departs between 4am and 8am, you can still capture demand associated with the time bins 8pm-midnight (day -1) and midnight-4am. However, if your flight departs between 8am and noon, you cannot capture demand that was available earlier than midnight (so you can capture from midnight-4am at most). Also, if your flight departs on night 3, this flight cannot capture demand from night 1 or 2. Besides, you cannot capture demand that has still not arrived or originated at the origin airport.

Finally, assume you can fly at maximum capacity (load factor = 100%).

C. Revenue

Revenue is generated by transporting cargo. To determine the revenue, yield is expressed in € per Revenue-Ton-Kilometer (RTK), which in this assignment is constant and equals 0.26 €/RTK. The following revenue formula must be used, which depends on the distance flown:

$$R_{i,j} = Yield_{i,j} \times d_{i,j} \times flow_{i,j}$$

where:

- $R_{i,j}$ is the revenue generated in the route between airports i and j.
- $Yield_{i,j}$ is the yield in € between airports i and j.
- $d_{i,j}$ is the distance in km between airports i and j.
- $flow_{i,j}$ is the cargo flow being transported between airports i and j.

D. Costs

You have to use the same costs breakdown as in Assignment 1, which includes leasing costs and operating costs (fixed operating costs, time-based costs and fuel costs) but they **do not** have the same value. It is therefore sufficient if you use your previous calculations and update those with the new aircraft-dependent parameters.

E. Other considerations

Consider the following elements:

- Besides the flight time and the TAT, assume that
  - the aircraft takes 15 min extra for take-off and get to cruise position;
  - the aircraft takes 15 min extra for approaching the destination airport and landing.
- Divide your scheduling horizon (120 hours) into time stages of 6 minutes. That is, each hour will be divided into 10-time stages, where, e.g., 5.4 = 5h24min.

F. Individual workload

To distinguish between each student's workload in the group, you are required toindicate each group member's workload in three separate disciplines. Provide the workload distribution in a separate file uploaded along with the assignment and follow the template below (or similar).

Student names	Modelling framework (30%)	Programming (50%)	Reporting (20%)
Student name #1	# %	# %	# %
Student name #2	# %	# %	# %
Student name #3	# %	# %	# %