Assignment 2

AE4423 – Airline Planning & Optimisation 2025/2026

Deadline: **17h, 16^{th} January 2026**

First read the entire assignment carefully (including the appendices) to extract all information required to adapt the models presented in the lectures!

For each problem, describe the mathematical model, your assumptions, results, and KPIs for each of the assignments in detail in a comprehensive report. Use figures and tables to present your results and KPIs and support your conclusions.

The report shall not contain any computer **code**. Add your Python code in BrightSpace as a zip file. Make sure that it is clear and well commented.

Submit your report and model script file(s) through BrightSpace at the latest on January 16^{th}, 17h. The report should have no more than **15 pages A4**. Note that the report shall not contain any computer code. Don't forget to include the group number, names, and student IDs in the report and script file(s). 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 past the deadline.

Minimum 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 5.5 in that case.

Grading of the report is:

- 30% - Mathematical modeling. Correct declaration of objectives and constraints.
- 50% - Programming logic. Correct logic of the simulation. The simulation answers the question.
- 20% - Reporting. Clear report with proper conclusions. Proper use of use figures and tables to present the results.

Contents

Introduction

A new passenger airline that will start 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 .

Do not take values from Assignment 1 into account. For this assignment, consider the new data files:

- *FleetType.xlsx* - information on the available aircraft fleet
- *DemandGroupX.xlsx* - information on the demand (X indicates your group number), plus information on 20 airports
- *HourCoefficients.xlsx* - information on the demand coefficients per hour

Question 1 - Aircraft Routing Problem

With the data available in the Excel data files and the Appendices, determine the flight schedule and aircraft routing for a period of **one day (24-hour period)**. You must 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 day at the hub airport** and that **only flights to and from the hub** are considered. The goal is to maximize the profit over this period.

To achieve this goal, you need to:

1. Apply the **dynamic programming** framework presented during the lectures to solve the problem.
2. Setup a Python computer model according to the dynamic programming framework. You should not use any commercial solver. In your report, add 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.

Additional information:

- You do **not** have to use all the aircraft in your fleet. Only if it is profitable.
- Your airline will only consider adding aircraft routes that:
  - Have a minimum of 6 hours of **block time** per day.
  - Respect **range** and **runway** constraints.
- 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 (24 hours) into **time stages of 6 minutes**. That is, each half an hour would have 5 'time steps' as $6 \times 5 = 30$ minutes.
- You can choose to stay at the same airport instead of flying.

Appendices

A - Demand Management

The demand per hour can be computed by multiplying the daily demand (demand matrix given) by the hour-coefficients given in the Excel attached to this assignment. Use the following formula:

$$Dem(t)_{i,j} = Dem_{i,j} \times Coef(t)_i, \tag{1}$$

where :

- $Dem(t)_{i,j}$ is the demand for hour t in route from i to j
- $Dem_{i,j}$ is the given demand data in route from i to j
- $Coef(t)_i$ is the coefficient per hour t as given in file *AirportData.xlsx*

Additionally, take into account that:

- The demand is given per route.
- Demand for a given hour of the day will be available at any (departure) time within that hour.

When you fly at hour t, you can assume that you can capture the demand you estimated for hours t, $t-1$, and $t-2$. After adding an aircraft route to your solution, you should remove the demand that you have transported. To do this, remove the demand from t, $t-1$, and $t-2$, sequential, until the aircraft is full or no more demand is available.

B - Revenue

Revenue is generated by transporting passengers. To determine the revenue for Problem 1, yield is expressed in € per Revenue-Passenger-Kilometer (RPK). The following revenue formula is used:

- For intra-European passengers, **yield** depends on distance:

  $$Y_{EUR_{i,j}} = 5.9 d_{ij}^{-0.76} + 0.043$$

  where:

  - $Y_{EUR_{i,j}}$ is the yield in € between origin i and destination j.
  - d_{ij} is the distance in km between origin i and destination j.

In order to develop a profitable network, fleet and frequency plan, the average load factor needs to be estimated. Assume a **load factor** of 80%.

C - Costs

The operation of your aircraft induces costs. Consider the same operating costs breakdown as in *Assignment 1*:

- All aircraft are **leased**, and therefore a leasing cost needs to be accounted for. The daily leasing cost is a fixed amount depending on the type of aircraft.
- **Operating costs** consist of three components:
  - **Fixed operating costs** (C_X^k) are costs per **flight leg** and represent costs such as landing rights, parking fees and fixed fuel cost. They depend only on the aircraft type k.
  - **Time-based costs** (C_T^k) are costs that are defined in € per flight hour, and represent time-dependent operating costs such as cabin and flight crew. They depend on the distance of the flight leg and the aircraft type k. Time costs can be defined as follows:

    $$C_{T_{ij}}^k = c_T^k \frac{d_{ij}}{V^k}$$

    where:

    * $C_{T_{ij}}^k$ is the total time cost for a flight leg between airports i and j operated by aircraft type k.
    * C_T^k is the time cost parameter for the aircraft type k.
    * V_k is the airspeed of aircraft type k.
  - **Fuel costs** C_F^k are dependent on the distance flown, and can be expressed as follows:

    $$C_{F_{ij}}^k = \frac{c_F^k \times f}{1.5} d_{ij}$$

    where:

    * $C_{F_{ij}}^k$ is the fuel cost for a flight leg between airports i and j operated by aircraft type k.
    * c_F^k is the fuel cost parameter for aircraft type k.
    * f is the fuel cost, equal to 1.42 USD/gallon.

The **total operating cost** for a **flight leg** between airports i and j operated by aircraft type k can then be expressed as:

$$C_{ij}^k = C_X^k + C_{T_{ij}}^k + C_{F_{ij}}^k$$