

Grupo G110

Composto por:

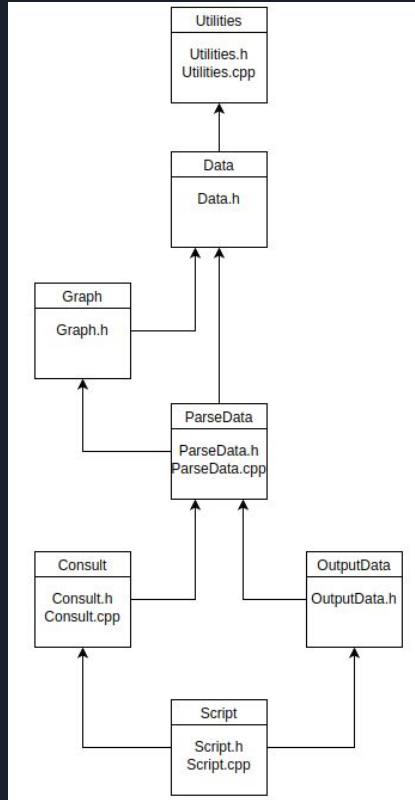
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Air Travel Flight Management System - AED 23/24

Class Diagram





Dataset reading description

At first, we read and parse all the information from the file “airlinesCSV”, extract it, create an airline object and insert it into a set data structure called “airlinesInfo”.

After it, we read and parse all the information from the file “airportsCSV”, extract it, create an airport object and add it into a graph data structure called “dataGraph”.

Lastly, we read and parse all the information from the file “flightsCSV”, extract it, and then we retrieve airports information from the graph “dataGraph”, add an edge between source and target airports, increment a flight count and associate an airline for the corresponding edge.

Graph description

Our graph is composed by:

- Airports representing vertex.
- Flight routes representing edges.
- Airline flights representing tags for edges.





List of implemented functions

- Smallest path between Airports:

Algorithm: Utilizes BFS

Complexity: $O(V + E)$

- Find Closest Airports:

Iterates through all airports, calculates the Haversine distance to each airport, and identifies the closest ones.

Complexity: $O(V * \log(V))$

- Essential Airports:

Algorithm: Utilizes DFS

Complexity: $O(V + E)$



List of implemented functions

- Number of reachable Airports/Cities/Countries in X stops from airport:

Algorithm: Utilizes BFS

Complexity: $O(V + E)$

- Maximum trip :

Algorithm: Utilizes BFS

Complexity: $O(V * (V + E))$

- Number of Flights per City/Airline:

Algorithm: Utilizes DFS

Complexity: $O(V + E)$



List of implemented functions

- Top traffic capacity Airports:

Identifies airports with the highest traffic capacity

Complex: $O(V * \log(V))$

- Find Airports by Airports/City/Country name:

Complex: $O(V * M * \log(V))$, where M is the length of the string name

- Find Airports by Code:

Complex: $O(V * C)$, where C is the length of the code

User interface

Just some examples

```
+-----+
| MAIN MENU |
+-----+
1. Travel
2. Statistics
3. Export data as text file
4. [Exit]

Enter your choice: █
```

Pressing 2

```
+-----+
| NETWORK STATISTICS |
+-----+
1. Global Statistics
2. Airport Statistics
3. Search Airlines
4. [Back]

Enter your choice: █
```

Pressing 1

```
+-----+
| GLOBAL STATISTICS |
+-----+
1. Airports
2. Flights
3. Flight routes
4. Number of flights per city
5. Number of flights per airline
6. Number of different countries that a given city flies to
7. Maximum trip
8. Top airports with greatest air traffic capacity
9. Essential airports
10. [Back]

Enter your choice: █
```

Pressing 6 and typing "Porto"
and "Portugal"

```
Enter the city name: Porto
Enter the country name: Portugal
```

```
You can fly to 16 different countries from Porto, Portugal
```

```
Press ENTER to continue...█
```


User interface

```
+-----+
| MAIN MENU |
+-----+
1. Travel
2. Statistics
3. Export data as text file
4. [Exit]

Enter your choice: █
```

Pressing 2

```
+-----+
| NETWORK STATISTICS |
+-----+
1. Global Statistics
2. Airport Statistics
3. Search Airlines
4. [Back]

Enter your choice: █
```

Pressing 1

```
+-----+
| GLOBAL STATISTICS |
+-----+
1. Airports
2. Flights
3. Flight routes
4. Number of flights per city
5. Number of flights per airline
6. Number of different countries that a given city flies to
7. Maximum trip
8. Top airports with greatest air traffic capacity
9. Essential airports
10. [Back]

Enter your choice: █
```

Pressing 7

```
Maximum trip: 12
Paths of the trip(s):
THU ▶ NAQ ▶ JUV ▶ JAV ▶ GOH ▶ KEF ▶ YYZ ▶ YDF ▶ YJR ▶ YRG ▶ YMN ▶ YSO ▶ YHO
THU ▶ NAQ ▶ JUV ▶ JAV ▶ GOH ▶ KEF ▶ YEG ▶ YUL ▶ YZV ▶ YNA ▶ YHR ▶ YIF ▶ YBX
THU ▶ NAQ ▶ JUV ▶ JAV ▶ GOH ▶ KEF ▶ YEG ▶ YUL ▶ YZV ▶ YNA ▶ YHR ▶ ZTB ▶ ZLT
THU ▶ NAQ ▶ JUV ▶ JAV ▶ GOH ▶ KEF ▶ SEA ▶ ANC ▶ ANI ▶ CHU ▶ CKD ▶ SLQ ▶ SRV
ZLT ▶ ZTB ▶ YHR ▶ YNA ▶ YZV ▶ YQB ▶ YYZ ▶ KEF ▶ GOH ▶ JAV ▶ JUV ▶ NAQ ▶ THU
ZLT ▶ ZTB ▶ YHR ▶ YNA ▶ YZV ▶ YQB ▶ ORD ▶ ANC ▶ ANI ▶ CHU ▶ CKD ▶ SLQ ▶ SRV
YBX ▶ YIF ▶ YHR ▶ YNA ▶ YZV ▶ YQB ▶ YYZ ▶ KEF ▶ GOH ▶ JAV ▶ JUV ▶ NAQ ▶ THU
YBX ▶ YIF ▶ YHR ▶ YNA ▶ YZV ▶ YQB ▶ ORD ▶ ANC ▶ ANI ▶ CHU ▶ CKD ▶ SLQ ▶ SRV
YHO ▶ YSO ▶ YMN ▶ YRG ▶ YJR ▶ YDF ▶ YYZ ▶ DXB ▶ BNE ▶ CTL ▶ ULP ▶ WNR ▶ BVI
YHO ▶ YSO ▶ YMN ▶ YRG ▶ YJR ▶ YDF ▶ YYZ ▶ CDG ▶ BSB ▶ MAB ▶ RDC ▶ CDJ ▶ CMP
YHO ▶ YSO ▶ YMN ▶ YRG ▶ YJR ▶ YDF ▶ YYZ ▶ KEF ▶ GOH ▶ JAV ▶ JUV ▶ NAQ ▶ THU
YHO ▶ YSO ▶ YMN ▶ YRG ▶ YJR ▶ YHZ ▶ ORD ▶ ANC ▶ ANI ▶ CHU ▶ CKD ▶ SLQ ▶ SRV
YHO ▶ YSO ▶ YMN ▶ YRG ▶ YJR ▶ YDF ▶ YYZ ▶ YVR ▶ SYD ▶ TWB ▶ SGO ▶ CMA ▶ XTG
BVI ▶ BEU ▶ BOL ▶ ISA ▶ BNE ▶ DXB ▶ YYZ ▶ YDF ▶ YJR ▶ YRG ▶ YMN ▶ YSO ▶ YHO
PTJ ▶ MEB ▶ FLS ▶ LST ▶ BNE ▶ DXB ▶ YYZ ▶ YDF ▶ YJR ▶ YRG ▶ YMN ▶ YSO ▶ YHO
XTG ▶ CMA ▶ SGO ▶ TWB ▶ BNE ▶ DXB ▶ YYZ ▶ YDF ▶ YJR ▶ YRG ▶ YMN ▶ YSO ▶ YHO
STZ ▶ SXO ▶ GRP ▶ MQH ▶ BSB ▶ CDG ▶ YUL ▶ YHZ ▶ YJR ▶ YRG ▶ YMN ▶ YSO ▶ YHO
STZ ▶ SXO ▶ GRP ▶ MQH ▶ BSB ▶ CDG ▶ LAX ▶ ANC ▶ ANI ▶ CHU ▶ CKD ▶ SLQ ▶ SRV

Press ENTER to continue... █
```

```
Processing...
Please wait a few seconds...
█
```

User interface

```
+-----+
| NETWORK STATISTICS |
+-----+
1. Global Statistics
2. Airport Statistics
3. Search Airlines
4. [Back]

Enter your choice: █
```

Pressing 2

```
+-----+
| SEARCH |
+-----+
1. Search Airport by Code
2. Search Airport by Name
3. Search Airport by City's name
4. Search Airport by Country's name
5. Search Closest Airport
6. [Back]

Enter your choice: █
```

Pressing 1

```
+-----+
| Find airport by airport's code |
+-----+
Enter airport code: █
```

Typing "OPO"

```
+-----+
| AIRPORT INFORMATION |
+-----+
Code: OPO
Name: Porto
City: Porto
Country: Portugal
Location: (41.2481, -8.68139)
```

1. See airport statistics
2. See reachable destinations in a maximum of X stops
3. [Back]

Enter your choice: █

Pressing 1

```
+-----+
| OPO Statistics |
+-----+
- Flight routes out of this airport: 61
- Flights out of this airport: 100
- Flights out of this airport (from different airlines): 22
- Number of different countries flown to: 16
- Available airports: 2994
- Available cities: 2935
- Available countries: 225

Press ENTER to continue...█
```

User interface

```
+-----+
| NETWORK STATISTICS |
+-----+
1. Global Statistics
2. Airport Statistics
3. Search Airlines
4. [Back]

Enter your choice: █
```

Pressing 2

```
+-----+
| SEARCH |
+-----+
1. Search Airport by Code
2. Search Airport by Name
3. Search Airport by City's name
4. Search Airport by Country's name
5. Search Closest Airport
6. [Back]

Enter your choice: █
```

Pressing 2

```
+-----+
| Search airport by airport's name |
+-----+
Enter airport name: █
```

Typing "Porto" and pressing 3

```
+-----+
| Search Airport by airport's name |
+-----+
Found 4 airport(s) containing 'Porto' in name

1. [BPS] Aeroporto de Porto Seguro, Porto Seguro, Brazil
2. [PLN] Pellston Regional Airport of Emmet County Airport, Pellston, United States
3. [OP0] Porto, Porto, Portugal
4. [PX0] Porto Santo, Porto Santo, Portugal
5. [Back]

Enter your choice: █
```

```
+-----+
| AIRPORT INFORMATION |
+-----+
Code: OPO
Name: Porto
City: Porto
Country: Portugal
Location: (41.2481, -8.68139)

1. See airport statistics
2. See reachable destinations in a maximum of X stops
3. [Back]

Enter your choice: █
```

Pressing 2 and typing 5

```
+-----+
| Destinations available with X Lay-Overs |
+-----+
From OPO in a maximum of 5 lay-overs

Reachable airports: 2983
Reachable cities: 2879
Reachable countries: 225

Press ENTER to continue...█
```

User interface

```
+-----+
| NETWORK STATISTICS |
+-----+
1. Global Statistics
2. Airport Statistics
3. Search Airlines
4. [Back]

Enter your choice: █
```

Pressing 2

```
+-----+
| SEARCH |
+-----+
1. Search Airport by Code
2. Search Airport by Name
3. Search Airport by City's name
4. Search Airport by Country's name
5. Search Closest Airport
6. [Back]

Enter your choice: █
```

Pressing 2

```
+-----+
| Search airport by city's name |
+-----+
Enter city name: █
```

Typing "Porto" and pressing 3

```
+-----+
| AIRPORT INFORMATION |
+-----+
Code: OPO
Name: Porto
City: Porto
Country: Portugal
Location: (41.2481, -8.68139)
```

1. See airport statistics
2. See reachable destinations in a maximum of X stops
3. [Back]

Enter your choice: █

```
+-----+
| Search Airport by city's name |
+-----+
Found 5 airport(s) in 'Porto'
```

1. [BPS] Aeroporto de Porto Seguro, Porto Seguro, Brazil
2. [PVH] Governador Jorge Teixeira De Oliveira, Porto Velho, Brazil
3. [OPO] Porto, Porto, Portugal
4. [PX0] Porto Santo, Porto Santo, Portugal
5. [POA] Salgado Filho, Porto Alegre, Brazil
6. [Back]

Enter your choice: █

Pressing 4

```
+-----+
| Search airport by country's name |
+-----+
Enter country name: █
```

Typing "Portugal"

```
+-----+
| Search Airport by country's name |
+-----+
Found 14 airport(s) in 'Portugal'

1. [CVU] Corvo Airport, Corvo, Portugal
2. [FAO] Faro, Faro, Portugal
3. [FLW] Flores, Flores, Portugal
4. [GRW] Graciosa, Graciosa Island, Portugal
5. [HOR] Horta, Horta, Portugal
6. [TER] Lajes, Lajes (terceira Island), Portugal
7. [LIS] Lisboa, Lisbon, Portugal
8. [FNC] Madeira, Funchal, Portugal
9. [PIX] Pico, Pico, Portugal
10. [PDL] Ponta Delgada, Ponta Delgada, Portugal
11. [OPO] Porto, Porto, Portugal
12. [PX0] Porto Santo, Porto Santo, Portugal
13. [SMA] Santa Maria, Santa Maria (island), Portugal
14. [SJZ] Sao Jorge, Sao Jorge Island, Portugal
15. [Back]
```

Enter your choice: █

User interface

```
+-----+
| MAIN MENU |
+-----+
1. Travel
2. Statistics
3. Export data as text file
4. [Exit]
```

Enter your choice:

Pressing 2

```
+-----+
| NETWORK STATISTICS |
+-----+
1. Global Statistics
2. Airport Statistics
3. Search Airlines
4. [Back]
```

Enter your choice:

Pressing 2

```
+-----+
| SEARCH |
+-----+
1. Search Airport by Code
2. Search Airport by Name
3. Search Airport by City's name
4. Search Airport by Country's name
5. Search Closest Airport
6. [Back]
```

Enter your choice:

Pressing 5

```
+-----+
| Search closest Airport |
+-----+
Enter latitude: 
```

Typing "41.179, -8.594"
(FEUP coordinates)

```
+-----+
| AIRPORT INFORMATION |
+-----+
Code: OPO
Name: Porto
City: Porto
Country: Portugal
Location: (41.2481, -8.68139)

1. See airport statistics
2. See reachable destinations in a maximum of X stops
3. [Back]
```

Enter your choice:

Pressing 1

```
+-----+
| Search closest Airport |
+-----+
Enter latitude: 41.179
Enter longitude: -8.594

Found 1 airport(s) closest to (41.179, -8.594)

1. OPO, Porto, Porto, Portugal, (41.2481,-8.68139)
2. [Back]
```

Enter your choice:

User interface

```
+-----+
|  MAIN MENU  |
+-----+
1. Travel
2. Statistics
3. Export data as text file
4. [Exit]

Enter your choice: █
```

Pressing 1

```
+-----+
|  TRAVEL MENU  |
+-----+
1. Best flight option
2. [Back]

Enter your choice: █
```

Pressing 1

```
+-----+
|  SELECT FLIGHT SOURCE  |
+-----+
1. Airport by Code
2. Airport by Name
3. City
4. Coordinates
5. [Back]

Enter your choice: █
```

Pressing 2

```
+-----+
|  AIRPORT INFORMATION  |
+-----+
Code: OPO
Name: Porto
City: Porto
Country: Portugal
Location: (41.2481, -8.68139)

0. Set airport as source
1. See airport statistics
2. See reachable destinations in a maximum of X stops
3. [Back]

Enter your choice: █
```

Pressing 0

```
+-----+
|  Search Airport by airport's name  |
+-----+
Found 4 airport(s) containing 'Porto' in name

1. [BPS] Aeroporto de Porto Seguro, Porto Seguro, Brazil
2. [PLN] Pellston Regional Airport of Emmet County Airport, Pellston, United States
3. [OPO] Porto, Porto, Portugal
4. [PX0] Porto Santo, Porto Santo, Portugal
5. [Back]

Enter your choice: █
```

Pressing 3

```
+-----+
|  Search airport by airport's name  |
+-----+
Enter airport name: █
```

Typing "Porto"

User interface

Continuation of the previous example..

```
+-----+
| SELECT FLIGHT DESTINATION |
+-----+
Source: OP0, Porto, Porto, Portugal, (41.2481,-8.68139)

1. Airport by Code
2. Airport by Name
3. City
4. Coordinates
5. [Back]

Enter your choice: █
```

Pressing 3

```
+-----+
| Search by city |
+-----+
Enter city name: █

+-----+
| Search by city |
+-----+
Enter city name: Brussels
Enter country name: █
```

Typing "Brussels" and
"Belgium"

```
+-----+
| Details about the trip |
+-----+
Total distance: 1473.4 km

1. OP0, Porto, Porto, Portugal, (41.2481,-8.68139)
   [Available Airlines]: DAT, FOS, IBE, RYR, TAP
   ▼
2. BRU, Brussels Natl, Brussels, Belgium, (50.9014,4.48444)

Press ENTER to continue...█
```

```
+-----+
| Extra filters |
+-----+
1. Show best flights
2. Add custom layovers
3. [Back]

Note: option 2 is to add specific layover airports that your flight must pass through

Enter your choice: █
```

Pressing 1

```
+-----+
| Best Flights |
+-----+
Source: OP0, Porto, Porto, Portugal, (41.2481,-8.68139)
Destination: Brussels, Belgium

1. Best flights in the same airline
2. Best flights considering all airlines
3. [Back]

Enter your choice: █
```

Pressing 1

```
Source: OP0, Porto, Porto, Portugal, (41.2481,-8.68139)
Destination: Brussels, Belgium

Best flight is with 0 lay-over(s)
1. OP0 ► BRU (1473.4 km)
2. [Back]

Enter your choice: █
```

Pressing 1

Highlight function

The filter “Custom Layovers” is our highlight of this project, it works implementing layovers when searching for best flights options. In short, you can choose an airport as source and an airport as destination, after that you can add as many layovers as you want between these airports.

```
+-----+
| Extra filters |
+-----+
Custom Layovers: MAD, LTN, LIN, SXF

0. Clear custom layovers list
1. Show best flights
2. Add custom layovers
3. [Back]

Note: option 2 is to add specific layover airports that your flight must pass through

Enter your choice: █
```



```
+-----+
| Add a Custom Layover |
+-----+
1. Airport by Code
2. Airport by Name
3. City
4. Coordinates
5. [Back]

Enter your choice: █
```



```
+-----+
| Best Flights |
+-----+
Source: OPO, Porto, Porto, Portugal, (41.2481,-8.68139)
Destination: CRL, Brussels South, Charleroi, Belgium, (50.4592,4.45382)
Custom Layovers: MAD, LTN, LIN, SXF

1. Best flights in the same airline
2. Best flights considering all airlines
3. [Back]

Enter your choice: █
```



```
ERROR: No flights found between the selected source and destination.

Press ENTER to continue...█
```

For example, in this situation it was added four obligatory layovers between Porto and Brussels, if you choose the best flights in the same airline, none would be found, but if you consider all airlines you would find more than 4000 choices, as you can see in the next slide.

Highlight function

```
4044. OPO ► MAD ► LTN ► CTA ► LIN ► MAD ► SXF ► LPA ► CRL (14401.3 km)
4045. OPO ► MAD ► LTN ► OTP ► LIN ► ARN ► SXF ► TFS ► CRL (14421.2 km)
4046. OPO ► MAD ► LTN ► MLA ► LIN ► MAD ► SXF ► FUE ► CRL (14421.5 km)
4047. OPO ► MAD ► LTN ► OTP ► LIN ► MAD ► SXF ► ACE ► CRL (14447.7 km)
4048. OPO ► MAD ► LTN ► MLA ► LIN ► DUB ► SXF ► TFS ► CRL (14496 km)
4049. OPO ► MAD ► LTN ► CTA ► LIN ► MAD ► SXF ► TFS ► CRL (14501 km)
4050. OPO ► MAD ► LTN ► OTP ► LIN ► DUB ► SXF ► LPA ► CRL (14542.4 km)
4051. OPO ► MAD ► LTN ► OTP ► LIN ► MAD ► SXF ► FUE ► CRL (14567.7 km)
4052. OPO ► MAD ► LTN ► OTP ► LIN ► DUB ► SXF ► TFS ► CRL (14642.2 km)
4053. OPO ► MAD ► LTN ► MLA ► LIN ► MAD ► SXF ► LPA ► CRL (14672 km)
4054. OPO ► MAD ► LTN ► MLA ► LIN ► MAD ► SXF ► TFS ► CRL (14771.8 km)
4055. OPO ► MAD ► LTN ► OTP ► LIN ► MAD ► SXF ► LPA ► CRL (14818.2 km)
4056. OPO ► MAD ► LTN ► OTP ► LIN ► MAD ► SXF ► TFS ► CRL (14918 km)
4057. [Back]
```

Enter your choice: █

You can choose any of these 4056 options, in this case it was chosen the option 4051, showing all the details of that trip.



```
+-----+
| Details about the trip |
+-----+
Total distance: 14567.7 km

1. OPO, Porto, Porto, Portugal, (41.2481,-8.68139)
   [Available Airlines]: IBE, RYR, RZO, TAP, THA, USA
   ▼
2. MAD, Barajas, Madrid, Spain, (40.4936,-3.56676)
   [Available Airlines]: EZY
   ▼
3. LTN, Luton, London, United Kingdom, (51.8747,-0.368333)
   [Available Airlines]: WZZ
   ▼
4. OTP, Henri Coanda, Bucharest, Romania, (44.5722,26.1022)
   [Available Airlines]: AZA, ROT
   ▼
5. LIN, Linate, Milan, Italy, (45.4451,9.27674)
   [Available Airlines]: IBE
   ▼
6. MAD, Barajas, Madrid, Spain, (40.4936,-3.56676)
   [Available Airlines]: EZY
   ▼
7. SXF, Schonefeld, Berlin, Germany, (52.38,13.5225)
   [Available Airlines]: CFG
   ▼
8. FUE, Fuerteventura, Fuerteventura, Spain, (28.4527,-13.8638)
   [Available Airlines]: RYR
   ▼
9. CRL, Brussels South, Charleroi, Belgium, (50.4592,4.45382)

Press ENTER to continue...█
```



Effort of each member of the group

Bruno Huang - 40%

Gabriel Moura - 20%

Ricardo Yang - 40%