

# Flight Network management system

## 1.0

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# Chapter 1

## Air Travel Flight Management System

### 1.1 Overview

Welcome to the Air Travel Flight Management System! This system is designed to help users explore and plan their air travel efficiently. It leverages real-world data about airports, airlines, and flights to provide a comprehensive tool for making informed decisions.

### 1.2 Dataset

The system utilizes a dataset containing information about 3019 airports, 444 airlines, and 63832 flights. This dataset includes details such as airport codes, names, cities, countries, latitude, and longitude, among other information.

### 1.3 Features

#### 1.3.1 Data Handling

- Read and parse provided data, loading it into an appropriate graph data structure.

#### 1.3.2 Flight Management System

- Develop a user-friendly system with functionalities for exploring and planning air travel.

#### 1.3.3 Network Statistics

- Calculate and list statistics such as the global number of airports and flights.
- Provide statistics on flights per airport, per city, per airline, and more.

### 1.3.4 Maximum Trip and Essential Airports

- Identify the maximum number of stops for a round-trip.
- Identify essential airports for the network's circulation capability.

### 1.3.5 Best Flight Options

- Present the best flight options based on user-specified criteria, such as airport code, name, city, or coordinates.

### 1.3.6 Flight Filtering

- Allow users to filter flight options based on preferences, such as specific airlines or minimizing the number of different airlines.

### 1.3.7 Documentation

- Include Doxygen documentation for relevant functions, indicating their time complexity.

## 1.4 Implementation Details

This system is implemented in C++ using the provided [Graph](#) class for managing the network of airports and flights. The data is loaded from CSV files, and various functionalities are provided to assist users in navigating the flight network.

## 1.5 How to Use

To get started, instantiate the [FlightNetwork](#) class with filenames for airlines, airports, and flights data. Then, use the provided functions to explore the features mentioned above.

To run the code, run the following commands:

```
mkdir build
cd build
cmake ..
make
./aed_project2
```

## 1.6 Authors

Leonardo Garcia  
Marcel Madeiros  
Pedro Castro

### 1.6.1 Happy flying!

## Chapter 2

# Class Index

### 2.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

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## Chapter 3

# File Index

### 3.1 File List

Here is a list of all files with brief descriptions:

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# Chapter 4

## Class Documentation

### 4.1 Airline Class Reference

Represents an airline with specific attributes such as code, name, callsign, and country.

```
#include <Airline.hpp>
```

#### Public Member Functions

- [Airline](#) (const std::string [code](#), const std::string [name](#), const std::string [callsign](#), const std::string [country](#))  
*Constructor for creating an [Airline](#) object with specified attributes.*
- [Airline](#) (const std::string &[code](#))  
*Constructor for creating an [Airline](#) object with only the code specified.*
- std::string [getCode](#) () const  
*Gets the airline code.*
- void [setCode](#) (const std::string &c)  
*Sets the airline code.*
- std::string [getName](#) () const  
*Gets the name of the airline.*
- void [setName](#) (const std::string &n)  
*Sets the name of the airline.*
- std::string [getCallsign](#) () const  
*Gets the callsign of the airline.*
- void [setCallsign](#) (const std::string &c)  
*Sets the callsign of the airline.*
- std::string [getCountry](#) () const  
*Gets the country associated with the airline.*
- void [setCountry](#) (const std::string &c)  
*Sets the country associated with the airline.*

#### Private Attributes

- std::string [code](#)
- std::string [name](#)
- std::string [callsign](#)
- std::string [country](#)

#### 4.1.1 Detailed Description

Represents an airline with specific attributes such as code, name, callsign, and country.

## 4.1.2 Constructor & Destructor Documentation

### 4.1.2.1 Airline() [1/2]

```
Airline::Airline (
    const std::string code,
    const std::string name,
    const std::string callsign,
    const std::string country )
```

Constructor for creating an [Airline](#) object with specified attributes.

#### Parameters

<i>code</i>	The airline code.
<i>name</i>	The name of the airline.
<i>callsign</i>	The callsign of the airline.
<i>country</i>	The country associated with the airline.

### 4.1.2.2 Airline() [2/2]

```
Airline::Airline (
    const std::string & code )
```

Constructor for creating an [Airline](#) object with only the code specified.

#### Parameters

<i>code</i>	The airline code.
-------------	-------------------

## 4.1.3 Member Function Documentation

### 4.1.3.1 getCallsign()

```
string Airline::getCallsign ( ) const
```

Gets the callsign of the airline.

#### Returns

The callsign of the airline.

### 4.1.3.2 getCode()

```
string Airline::getCode ( ) const
```

Gets the airline code.

#### Returns

The airline code.

### 4.1.3.3 getCountry()

```
string Airline::getCountry ( ) const
```

Gets the country associated with the airline.

#### Returns

The country associated with the airline.



#### 4.1.3.4 getName()

```
string Airline::getName ( ) const
```

Gets the name of the airline.

##### Returns

The name of the airline.

#### 4.1.3.5 setCallsign()

```
void Airline::setCallsign (
    const std::string & c )
```

Sets the callsign of the airline.

##### Parameters

<i>c</i>	The new callsign of the airline.
----------	----------------------------------

#### 4.1.3.6 setCode()

```
void Airline::setCode (
    const std::string & c )
```

Sets the airline code.

##### Parameters

<i>c</i>	The new airline code.
----------	-----------------------

#### 4.1.3.7 setCountry()

```
void Airline::setCountry (
    const std::string & c )
```

Sets the country associated with the airline.

##### Parameters

<i>c</i>	The new country associated with the airline.
----------	--

#### 4.1.3.8 setName()

```
void Airline::setName (
    const std::string & n )
```

Sets the name of the airline.

##### Parameters

<i>n</i>	The new name of the airline.
----------	------------------------------

### 4.1.4 Member Data Documentation

#### 4.1.4.1 callsign

```
std::string Airline::callsign [private]
```

The callsign of the airline.

#### 4.1.4.2 code

`std::string Airline::code [private]`  
The airline code.

#### 4.1.4.3 country

`std::string Airline::country [private]`  
The country associated with the airline.

#### 4.1.4.4 name

`std::string Airline::name [private]`  
The name of the airline.

The documentation for this class was generated from the following files:

- [inc/Airline.hpp](#)
- [src/Airline.cpp](#)

## 4.2 Airport Class Reference

Represents an airport with attributes such as code, name, city, country, and position.

```
#include <Airport.hpp>
```

### Public Member Functions

- [Airport](#) (const [std::string](#) &[code](#), const [std::string](#) &[name](#), const [std::string](#) &[city](#), const [std::string](#) &[country](#), const [std::pair](#)< float, float > &[position](#))  
*Constructor for creating an [Airport](#) object with specified attributes.*
- [Airport](#) (const [std::string](#) &[code](#))  
*Constructor for creating an [Airport](#) object with only the code specified.*
- [std::string](#) [getCode](#) () const  
*Gets the airport code.*
- void [setCode](#) (const [std::string](#) &c)  
*Sets the airport code.*
- [std::string](#) [getName](#) () const  
*Gets the name of the airport.*
- void [setName](#) (const [std::string](#) &n)  
*Sets the name of the airport.*
- [std::string](#) [getCity](#) () const  
*Gets the city where the airport is located.*
- void [setCity](#) (const [std::string](#) &c)  
*Sets the city where the airport is located.*
- [std::string](#) [getCountry](#) () const  
*Gets the country where the airport is located.*
- void [setCountry](#) (const [std::string](#) &c)  
*Sets the country where the airport is located.*
- [std::pair](#)< float, float > [getPosition](#) () const  
*Gets the geographical position of the airport.*
- void [setPosition](#) (const [std::pair](#)< float, float > &pos)  
*Sets the geographical position of the airport.*
- bool [operator==](#) (const [Airport](#) &other)  
*Overloaded equality operator to compare airports based on their codes.*
- bool [operator<](#) (const [Airport](#) &other)  
*Overloaded less-than operator to compare airports based on their codes.*

### Private Attributes

- std::string [code](#)
- std::string [name](#)
- std::string [city](#)
- std::string [country](#)
- std::pair< float, float > [position](#)

## 4.2.1 Detailed Description

Represents an airport with attributes such as code, name, city, country, and position.

## 4.2.2 Constructor & Destructor Documentation

### 4.2.2.1 Airport() [1/2]

```
Airport::Airport (
    const std::string & code,
    const std::string & name,
    const std::string & city,
    const std::string & country,
    const std::pair< float, float > & position )
```

Constructor for creating an [Airport](#) object with specified attributes.

#### Parameters

<i>code</i>	The airport code.
<i>name</i>	The name of the airport.
<i>city</i>	The city where the airport is located.
<i>country</i>	The country where the airport is located.
<i>position</i>	The geographical position of the airport (latitude, longitude).

### 4.2.2.2 Airport() [2/2]

```
Airport::Airport (
    const std::string & code )
```

Constructor for creating an [Airport](#) object with only the code specified.

#### Parameters

<i>code</i>	The airport code.
-------------	-------------------

## 4.2.3 Member Function Documentation

### 4.2.3.1 getCity()

```
string Airport::getCity ( ) const
```

Gets the city where the airport is located.

#### Returns

The city where the airport is located.

### 4.2.3.2 getCode()

```
string Airport::getCode ( ) const
```

Gets the airport code.

**Returns**

The airport code.

**4.2.3.3 getCountry()**

```
string Airport::getCountry ( ) const
```

Gets the country where the airport is located.

**Returns**

The country where the airport is located.

**4.2.3.4 getName()**

```
string Airport::getName ( ) const
```

Gets the name of the airport.

**Returns**

The name of the airport.

**4.2.3.5 getPosition()**

```
pair< float, float > Airport::getPosition ( ) const
```

Gets the geographical position of the airport.

**Returns**

The geographical position of the airport (latitude, longitude).

**4.2.3.6 operator<()**

```
bool Airport::operator< (
    const Airport & other )
```

Overloaded less-than operator to compare airports based on their codes.

**Parameters**

<i>other</i>	The other airport to compare.
--------------	-------------------------------

**Returns**

True if the code of this airport is less than the code of the other airport.

**4.2.3.7 operator==()**

```
bool Airport::operator== (
    const Airport & other )
```

Overloaded equality operator to compare airports based on their codes.

**Parameters**

<i>other</i>	The other airport to compare.
--------------	-------------------------------

**Returns**

True if the airports have the same code, false otherwise.

**4.2.3.8 setCity()**

```
void Airport::setCity (
    const std::string & c )
```

Sets the city where the airport is located.

**Parameters**

<i>c</i>	The new city where the airport is located.
----------	--

**4.2.3.9 setCode()**

```
void Airport::setCode (
    const std::string & c )
```

Sets the airport code.

**Parameters**

<i>c</i>	The new airport code.
----------	-----------------------

**4.2.3.10 setCountry()**

```
void Airport::setCountry (
    const std::string & c )
```

Sets the country where the airport is located.

**Parameters**

<i>c</i>	The new country where the airport is located.
----------	---

**4.2.3.11 setName()**

```
void Airport::setName (
    const std::string & n )
```

Sets the name of the airport.

**Parameters**

<i>n</i>	The new name of the airport.
----------	------------------------------

**4.2.3.12 setPosition()**

```
void Airport::setPosition (
    const std::pair< float, float > & pos )
```

Sets the geographical position of the airport.

**Parameters**

<i>pos</i>	The new geographical position of the airport (latitude, longitude).
------------	---

## 4.2.4 Member Data Documentation

### 4.2.4.1 city

```
std::string Airport::city [private]
```

The city where the airport is located.

### 4.2.4.2 code

```
std::string Airport::code [private]
```

The airport code.

### 4.2.4.3 country

```
std::string Airport::country [private]
```

The country where the airport is located.

### 4.2.4.4 name

```
std::string Airport::name [private]
```

The name of the airport.

### 4.2.4.5 position

```
std::pair<float, float> Airport::position [private]
```

The geographical position of the airport (latitude, longitude).

The documentation for this class was generated from the following files:

- [inc/Airport.hpp](#)
- [src/Airport.cpp](#)

## 4.3 App Class Reference

```
#include <App.hpp>
```

### Public Member Functions

- [App](#) ([FlightNetwork](#) &[flightnetwork](#))
- void [mainMenu](#) ()
- void [statisticsMenu](#) ()
- void [bestFlightMenu](#) ()
- void [goBackStatisticsMenu](#) ()
- void [globalStatistics](#) ()
- void [showNumFlights](#) ()
- void [numberOfDestinations](#) ([Airport](#) &[airport](#))
- void [reachableDest](#) ([Airport](#) &[airport](#), int stops)

### Private Attributes

- [FlightNetwork](#) [flightnetwork](#)

## 4.3.1 Constructor & Destructor Documentation

### 4.3.1.1 App()

```
App::App (
    FlightNetwork & flightnetwork )
```

## 4.3.2 Member Function Documentation

### 4.3.2.1 bestFlightMenu()

```
void App::bestFlightMenu ( )
```

### 4.3.2.2 globalStatistics()

```
void App::globalStatistics ( )
```

### 4.3.2.3 goBackStatisticsMenu()

```
void App::goBackStatisticsMenu ( )
```

### 4.3.2.4 mainMenu()

```
void App::mainMenu ( )
```

### 4.3.2.5 numberOfDestinations()

```
void App::numberOfDestinations (
    Airport & airport )
```

### 4.3.2.6 reachableDest()

```
void App::reachableDest (
    Airport & airport,
    int stops )
```

### 4.3.2.7 showNumFlights()

```
void App::showNumFlights ( )
```

### 4.3.2.8 statisticsMenu()

```
void App::statisticsMenu ( )
```

## 4.3.3 Member Data Documentation

### 4.3.3.1 flightnetwork

```
FlightNetwork App::flightnetwork [private]
```

The documentation for this class was generated from the following files:

- inc/App.hpp
- src/App.cpp

## 4.4 Edge< T > Class Template Reference

Represents an edge between two vertices in a graph with generic information of type T.

```
#include <Graph.hpp>
```

### Public Member Functions

- [Edge](#) ([Vertex](#)< T > \*d, std::string in, double w)  
*Constructor for creating an edge with a specified destination vertex, information, and weight.*
- [Vertex](#)< T > \* [getDest](#) () const  
*Gets the destination vertex of the edge.*
- void [setDest](#) ([Vertex](#)< T > \*d)

- Sets the destination vertex of the edge.*
- `std::string getInfo () const`  
*Gets the information associated with the edge.*
- `void setInfo (std::string in)`  
*Sets the information associated with the edge.*
- `double getWeight () const`  
*Gets the weight of the edge.*
- `void setWeight (double weight)`  
*Sets the weight of the edge.*

#### Private Attributes

- `Vertex< T > * dest`
- `std::string info`
- `double weight`

#### Friends

- `class Graph< T >`
- `class Vertex< T >`

### 4.4.1 Detailed Description

`template<class T>`

`class Edge< T >`

Represents an edge between two vertices in a graph with generic information of type T.

Template Parameters

<code>T</code>	The type of information stored in the edge.
----------------	---

### 4.4.2 Constructor & Destructor Documentation

#### 4.4.2.1 Edge()

```
template<class T >
Edge< T >::Edge (
    Vertex< T > * d,
    std::string in,
    double w )
```

Constructor for creating an edge with a specified destination vertex, information, and weight.

Parameters

<code>d</code>	The destination vertex of the edge.
<code>in</code>	The information associated with the edge.
<code>w</code>	The weight of the edge.

### 4.4.3 Member Function Documentation

#### 4.4.3.1 getDest()

```
template<class T >
Vertex< T > * Edge< T >::getDest ( ) const
```



Gets the destination vertex of the edge.

**Returns**

The destination vertex of the edge.

**4.4.3.2 getInfo()**

```
template<class T >
std::string Edge< T >::getInfo ( ) const
```

Gets the information associated with the edge.

**Returns**

The information associated with the edge.

**4.4.3.3 getWeight()**

```
template<class T >
double Edge< T >::getWeight ( ) const
```

Gets the weight of the edge.

**Returns**

The weight of the edge.

**4.4.3.4 setDest()**

```
template<class T >
void Edge< T >::setDest (
    Vertex< T > * d )
```

Sets the destination vertex of the edge.

**Parameters**

<i>d</i>	The new destination vertex of the edge.
----------	---

**4.4.3.5 setInfo()**

```
template<class T >
void Edge< T >::setInfo (
    std::string in )
```

Sets the information associated with the edge.

**Parameters**

<i>in</i>	The new information associated with the edge.
-----------	---

**4.4.3.6 setWeight()**

```
template<class T >
void Edge< T >::setWeight (
    double weight )
```

Sets the weight of the edge.

## Parameters

<i>weight</i>	The new weight of the edge.
---------------	-----------------------------

## 4.4.4 Friends And Related Symbol Documentation

### 4.4.4.1 Graph< T >

```
template<class T >
friend class Graph< T > [friend]
Allow Graph class to access private members of Edge.
```

### 4.4.4.2 Vertex< T >

```
template<class T >
friend class Vertex< T > [friend]
Allow Vertex class to access private members of Edge.
```

## 4.4.5 Member Data Documentation

### 4.4.5.1 dest

```
template<class T >
Vertex<T>* Edge< T >::dest [private]
The destination vertex of the edge.
```

### 4.4.5.2 info

```
template<class T >
std::string Edge< T >::info [private]
Information associated with the edge.
```

### 4.4.5.3 weight

```
template<class T >
double Edge< T >::weight [private]
The weight of the edge.
```

The documentation for this class was generated from the following file:

- inc/Graph.hpp

## 4.5 FlightNetwork Class Reference

Represents a flight network consisting of airports and flights.

```
#include <FlightNetwork.hpp>
```

### Public Member Functions

- [FlightNetwork](#) ()  
*Default constructor for the FlightNetwork class.*
- [FlightNetwork](#) (const std::string &airlines\_filename, const std::string &airports\_filename, const std::string &flights\_filename)  
*Parameterized constructor for the FlightNetwork class.*
- [Graph< Airport > getAiportsGraph](#) ()  
*Getter function to retrieve the airports graph.*
- int [getGlobalNumOfAirports](#) () const  
*Get the total number of airports in the network.*

- int [getGlobalNumOfFlights](#) () const  
*Get the total number of flights in the network.*
- std::pair< int, int > [numFlightsAirport](#) (const [Airport](#) &airport)  
*Get the number of flights departing or arriving at a specific airport.*
- int [numFlightsCity](#) (const std::string &city) const  
*Get the total number of flights departing or arriving in a specific city.*
- int [numFlightsAirline](#) ([Airline](#) &airline) const  
*Get the total number of flights operated by a specific airline.*
- std::set< std::string > [getDiffCountriesAirport](#) (const [Airport](#) &airport) const  
*Get the set of different countries connected to a specific airport.*
- std::set< std::string > [getDiffCountriesCity](#) (const std::string &city) const  
*Get the set of different countries connected to airports in a specific city.*
- std::set< std::string > [getAirportsDestinations](#) (const [Airport](#) &airport) const  
*Get the set of airport names connected to a specific airport.*
- std::set< std::string > [getCitiesDestinations](#) (const [Airport](#) &airport) const  
*Get the set of city names connected to a specific airport.*
- std::set< std::string > [getCountriesDestinations](#) (const [Airport](#) &airport) const  
*Get the set of country names connected to a specific airport.*
- std::set< std::string > [getReachableAirports](#) (const [Airport](#) &airport, const int &distance)  
*Get the set of airport names reachable from a specific airport within a given distance.*
- std::set< std::string > [getReachableCities](#) (const [Airport](#) &airport, const int &distance)  
*Get the set of city names reachable from a specific airport within a given distance.*
- std::set< std::string > [getReachableCountries](#) (const [Airport](#) &airport, const int &distance)  
*Get the set of country names reachable from a specific airport within a given distance.*
- int [maximumTrip](#) (std::vector< std::pair< std::string, std::string > > &airports)  
*Find the maximum number of stops for a round-trip connecting the given airports.*
- std::set< std::string > [getGreatestTraffic](#) (const int &k)  
*Get the set of airports with the greatest traffic, considering both incoming and outgoing flights.*
- std::set< std::string > [getEssentialAirports](#) ()  
*Perform a depth-first search to identify essential airports in the flight network.*
- [Airport](#) [codeCriteria](#) (const std::string &code) const  
*Find an airport by its code.*
- [Airport](#) [nameCriteria](#) (const std::string &name) const  
*Find an airport by its name.*
- std::vector< [Airport](#) > [cityCriteria](#) (const std::string &city) const  
*Find airports in the specified city.*
- std::vector< [Airport](#) > [coordinateCriteria](#) (const float &lat, const float &lon) const  
*Find airports near the specified coordinates.*
- std::vector< vector< [Airport](#) > > [bestFlight](#) (const [Airport](#) &source, const [Airport](#) &destination, const set< string > &allowedAirlines={}, bool minimizeAirlines=false) const  
*Find the best flight paths between source and destination airports.*
- std::vector< std::vector< [Airport](#) > > [listBestFlights](#) (const int &flag1, const int &flag2, const set< string > &allowedAirlines, bool minimizeAirlines) const  
*List the best flights based on user input for source and destination.*
- std::string [airportCodeToName](#) (const std::string &code)  
*Convert an airport code to its corresponding name.*
- std::string [airlineCodeToName](#) (const std::string &code)  
*Convert an airline code to its corresponding name.*

### Private Attributes

- [Graph](#)< [Airport](#) > `airportsGraph`  
[Graph](#) representing the network of airports and flights.

## 4.5.1 Detailed Description

Represents a flight network consisting of airports and flights.

## 4.5.2 Constructor & Destructor Documentation

### 4.5.2.1 FlightNetwork() [1/2]

```
FlightNetwork::FlightNetwork ( )
```

Default constructor for the [FlightNetwork](#) class.

### 4.5.2.2 FlightNetwork() [2/2]

```
FlightNetwork::FlightNetwork (
    const std::string & airlines_filename,
    const std::string & airports_filename,
    const std::string & flights_filename )
```

Parameterized constructor for the [FlightNetwork](#) class.

#### Parameters

<code>airlines_filename</code>	Filename for the airlines data.
<code>airports_filename</code>	Filename for the airports data.
<code>flights_filename</code>	Filename for the flights data.

## 4.5.3 Member Function Documentation

### 4.5.3.1 airlineCodeToName()

```
string FlightNetwork::airlineCodeToName (
    const std::string & code )
```

Convert an airline code to its corresponding name.

This function takes an airline code and searches the dataset to find the corresponding airline name.

#### Parameters

<code>code</code>	The unique ICAO code of the airline.
-------------------	--------------------------------------

#### Returns

`std::string` The name of the airline.

#### Exceptions

<code>std::runtime_error</code>	if the airline with the given code is not found.
---------------------------------	--

### 4.5.3.2 airportCodeToName()

```
string FlightNetwork::airportCodeToName (
    const std::string & code )
```

Convert an airport code to its corresponding name.

This function takes an airport code and searches the dataset to find the corresponding airport name.

#### Parameters

<i>code</i>	The unique IATA code of the airport.
-------------	--------------------------------------

#### Returns

std::string The name of the airport.

#### Exceptions

<i>std::runtime_error</i>	if the airport with the given code is not found.
---------------------------	--

#### 4.5.3.3 bestFlight()

```
vector< vector< Airport > > FlightNetwork::bestFlight (
    const Airport & source,
    const Airport & destination,
    const set< string > & allowedAirlines = {},
    bool minimizeAirlines = false ) const
```

Find the best flight paths between source and destination airports.

#### Parameters

<i>source</i>	The source airport.
<i>destination</i>	The destination airport.
<i>allowedAirlines</i>	Set of allowed airlines (empty for any).
<i>minimizeAirlines</i>	Flag to minimize the number of unique airlines in the path.

#### Returns

Vector of vector of airports representing the best flight paths.

#### 4.5.3.4 cityCriteria()

```
vector< Airport > FlightNetwork::cityCriteria (
    const std::string & city ) const
```

Find airports in the specified city.

#### Parameters

<i>city</i>	The name of the city to search for.
-------------	-------------------------------------

#### Returns

Vector of airports in the given city.

#### Exceptions

<i>runtime_error</i>	if no city with the provided name is found.
----------------------	---

#### 4.5.3.5 codeCriteria()

```
Airport FlightNetwork::codeCriteria (
    const std::string & code ) const
```

Find an airport by its code.

##### Parameters

<i>code</i>	The code of the target airport.
-------------	---------------------------------

##### Returns

The airport matching the provided code.

##### Exceptions

<i>runtime_error</i>	if no airport is found with the given code.
----------------------	---

#### 4.5.3.6 coordinateCriteria()

```
vector< Airport > FlightNetwork::coordinateCriteria (
    const float & lat,
    const float & lon ) const
```

Find airports near the specified coordinates.

##### Parameters

<i>lat</i>	The latitude of the target location.
<i>lon</i>	The longitude of the target location.

##### Returns

Vector of airports near the specified coordinates.

##### Exceptions

<i>runtime_error</i>	if no airports are found in the specified area.
----------------------	---

#### 4.5.3.7 getAiportsGraph()

```
Graph< Airport > FlightNetwork::getAiportsGraph ( )
```

Getter function to retrieve the airports graph.

##### Returns

`Graph<Airport>` representing the airports and flights.

#### 4.5.3.8 getAirportsDestinations()

```
set< string > FlightNetwork::getAirportsDestinations (
    const Airport & airport ) const
```

Get the set of airport names connected to a specific airport.

## Parameters

<i>airport</i>	The target airport.
----------------	---------------------

## Returns

Set of airport names.

**4.5.3.9 getCitiesDestinations()**

```
set< string > FlightNetwork::getCitiesDestinations (
    const Airport & airport ) const
```

Get the set of city names connected to a specific airport.

## Parameters

<i>airport</i>	The target airport.
----------------	---------------------

## Returns

Set of city names.

**4.5.3.10 getCountriesDestinations()**

```
set< string > FlightNetwork::getCountriesDestinations (
    const Airport & airport ) const
```

Get the set of country names connected to a specific airport.

## Parameters

<i>airport</i>	The target airport.
----------------	---------------------

## Returns

Set of country names.

**4.5.3.11 getDiffCountriesAirport()**

```
set< string > FlightNetwork::getDiffCountriesAirport (
    const Airport & airport ) const
```

Get the set of different countries connected to a specific airport.

## Parameters

<i>airport</i>	The target airport.
----------------	---------------------

## Returns

Set of countries.

**4.5.3.12 getDiffCountriesCity()**

```
set< string > FlightNetwork::getDiffCountriesCity (
    const std::string & city ) const
```

Get the set of different countries connected to airports in a specific city.

## Parameters

<i>city</i>	The target city.
-------------	------------------

## Returns

Set of countries.

**4.5.3.13 getEssentialAirports()**

```
set< string > FlightNetwork::getEssentialAirports ( )
```

Perform a depth-first search to identify essential airports in the flight network.

## Returns

Set of essential airport names.

**4.5.3.14 getGlobalNumOfAirports()**

```
int FlightNetwork::getGlobalNumOfAirports ( ) const
```

Get the total number of airports in the network.

## Returns

Total number of airports.

**4.5.3.15 getGlobalNumOfFlights()**

```
int FlightNetwork::getGlobalNumOfFlights ( ) const
```

Get the total number of flights in the network.

## Returns

Total number of flights.

**4.5.3.16 getGreatestTraffic()**

```
set< string > FlightNetwork::getGreatestTraffic (
    const int & k )
```

Get the set of airports with the greatest traffic, considering both incoming and outgoing flights.

## Parameters

<i>k</i>	The number of airports to retrieve.
----------	-------------------------------------

## Returns

Set of airport names with the greatest traffic.

**4.5.3.17 getReachableAirports()**

```
set< string > FlightNetwork::getReachableAirports (
    const Airport & airport,
    const int & distance )
```

Get the set of airport names reachable from a specific airport within a given distance.



## Parameters

<i>airport</i>	The source airport.
<i>distance</i>	The maximum distance to consider.

## Returns

Set of reachable airport names.

**4.5.3.18 getReachableCities()**

```
set< string > FlightNetwork::getReachableCities (
    const Airport & airport,
    const int & distance )
```

Get the set of city names reachable from a specific airport within a given distance.

## Parameters

<i>airport</i>	The source airport.
<i>distance</i>	The maximum distance to consider.

## Returns

Set of reachable city names.

**4.5.3.19 getReachableCountries()**

```
set< string > FlightNetwork::getReachableCountries (
    const Airport & airport,
    const int & distance )
```

Get the set of country names reachable from a specific airport within a given distance.

## Parameters

<i>airport</i>	The source airport.
<i>distance</i>	The maximum distance to consider.

## Returns

Set of reachable country names.

**4.5.3.20 listBestFlights()**

```
vector< vector< Airport > > FlightNetwork::listBestFlights (
    const int & flag1,
    const int & flag2,
    const set< string > & allowedAirlines,
    bool minimizeAirlines ) const
```

List the best flights based on user input for source and destination.

## Parameters

<i>flag1</i>	Type of input for the source (1: code, 2: name, 3: city, 4: coordinate).
<i>flag2</i>	Type of input for the destination (1: code, 2: name, 3: city, 4: coordinate).
<i>allowedAirlines</i>	Set of allowed airlines (empty for any).
<i>minimizeAirlines</i>	Flag to minimize the number of unique airlines in the path.

**Returns**

Vector of vector of airports representing the best flight paths.

**4.5.3.21 maximumTrip()**

```
int FlightNetwork::maximumTrip (
    std::vector< std::pair< std::string, std::string > > & airports )
```

Find the maximum number of stops for a round-trip connecting the given airports.

**Parameters**

<i>airports</i>	A vector of pairs representing airport codes for the round-trip.
-----------------	--

**Returns**

The maximum number of stops for the round-trip.

**4.5.3.22 nameCriteria()**

```
Airport FlightNetwork::nameCriteria (
    const std::string & name ) const
```

Find an airport by its name.

**Parameters**

<i>name</i>	The name of the target airport.
-------------	---------------------------------

**Returns**

The airport matching the provided name.

**Exceptions**

<i>runtime_error</i>	if no airport is found with the given name.
----------------------	---

**4.5.3.23 numFlightsAirline()**

```
int FlightNetwork::numFlightsAirline (
    Airline & airline ) const
```

Get the total number of flights operated by a specific airline.

**Parameters**

<i>airline</i>	The target airline.
----------------	---------------------

**Returns**

Total number of flights.

**4.5.3.24 numFlightsAirport()**

```
pair< int, int > FlightNetwork::numFlightsAirport (
    const Airport & airport )
```

Get the number of flights departing or arriving at a specific airport.

## Parameters

<i>airport</i>	The target airport.
----------------	---------------------

## Returns

A pair containing the total number of flights and the number of different airlines.

## 4.5.3.25 numFlightsCity()

```
int FlightNetwork::numFlightsCity (
    const std::string & city ) const
```

Get the total number of flights departing or arriving in a specific city.

## Parameters

<i>city</i>	The target city.
-------------	------------------

## Returns

Total number of flights.

## 4.5.4 Member Data Documentation

## 4.5.4.1 airportsGraph

```
Graph<Airport> FlightNetwork::airportsGraph [private]
```

[Graph](#) representing the network of airports and flights.

The documentation for this class was generated from the following files:

- [inc/FlightNetwork.hpp](#)
- [src/FlightNetwork.cpp](#)

## 4.6 Graph&lt; T &gt; Class Template Reference

Represents a generic graph with vertices of type T.

```
#include <Graph.hpp>
```

## Public Member Functions

- [Vertex](#)< T > \* [findVertex](#) (const T &in) const  
*Finds a vertex with a given information in the graph.*
- int [getNumVertex](#) () const  
*Gets the number of vertices in the graph.*
- bool [addVertex](#) (const T &in)  
*Adds a vertex with the given information to the graph.*
- bool [removeVertex](#) (const T &in)  
*Removes the vertex with the given information from the graph.*
- bool [addEdge](#) (const T &sourc, const T &dest, const std::string &in, double w)  
*Adds an edge between vertices with source and destination information.*
- bool [removeEdge](#) (const T &sourc, const T &dest)  
*Removes the edge between vertices with source and destination information.*
- std::vector< [Vertex](#)< T > \* > [getVertexSet](#) () const  
*Gets the vector of vertices in the graph.*
- void [dfsVisit](#) ([Vertex](#)< T > \*v, std::vector< T > &res) const

- Helper function for depth-first search traversal of the graph.*

  - `std::vector< T > dfs () const`  
*Performs depth-first search traversal of the graph.*
  - `std::vector< T > dfs (const T &source) const`  
*Performs depth-first search traversal of the graph starting from a specific vertex.*
  - `std::vector< T > nodesAtDistanceDFS (const T &source, int k)`  
*Finds nodes at a specific distance from a source vertex using depth-first search.*
  - `std::vector< Edge< T > > EdgesAtDistanceDFS (const T &source, int k)`  
*Finds edges at a specific distance from a source vertex using depth-first search.*
  - `std::vector< T > bfs (const T &source) const`  
*Performs breadth-first search traversal of the graph starting from a specific vertex.*
  - `std::vector< std::pair< int, T > > bfsDistance (Vertex< T > *source)`  
*Performs breadth-first search traversal of the graph starting from a specific vertex and returns a vector of pairs containing the distance and information of each vertex.*
  - `void inDegree (Vertex< T > *source)`  
*Determines the in-degree of a specific vertex in the graph.*

#### Private Attributes

- `std::vector< Vertex< T > * > vertexSet`

### 4.6.1 Detailed Description

**template<class T>**  
**class Graph< T >**

Represents a generic graph with vertices of type T.

#### Template Parameters

<i>T</i>	The type of information stored in the vertices of the graph.
----------	--

### 4.6.2 Member Function Documentation

#### 4.6.2.1 addEdge()

```
template<class T >
bool Graph< T >::addEdge (
    const T & source,
    const T & dest,
    const std::string & in,
    double w )
```

Adds an edge between vertices with source and destination information.

#### Parameters

<i>source</i>	The information of the source vertex.
<i>dest</i>	The information of the destination vertex.
<i>in</i>	The information associated with the edge.
<i>w</i>	The weight of the edge.

#### Returns

True if the edge is added successfully, false if the source or destination vertex is not found.

#### 4.6.2.2 addVertex()

```
template<class T >
bool Graph< T >::addVertex (
    const T & in )
```

Adds a vertex with the given information to the graph.

##### Parameters

<i>in</i>	The information to be stored in the new vertex.
-----------	---

##### Returns

True if the vertex is added successfully, false if the vertex already exists.

#### 4.6.2.3 bfs()

```
template<class T >
std::vector< T > Graph< T >::bfs (
    const T & source ) const
```

Performs breadth-first search traversal of the graph starting from a specific vertex.

##### Parameters

<i>source</i>	The information of the starting vertex.
---------------	---

##### Returns

A vector containing the information of vertices in the order they are visited.

#### 4.6.2.4 bfsDistance()

```
template<class T >
std::vector< std::pair< int, T > > Graph< T >::bfsDistance (
    Vertex< T > * source )
```

Performs breadth-first search traversal of the graph starting from a specific vertex and returns a vector of pairs containing the distance and information of each vertex.

##### Parameters

<i>source</i>	The pointer to the starting vertex.
---------------	-------------------------------------

##### Returns

A vector of pairs containing the distance and information of each vertex.

#### 4.6.2.5 dfs() [1/2]

```
template<class T >
std::vector< T > Graph< T >::dfs ( ) const
```

Performs depth-first search traversal of the graph.

##### Returns

A vector containing the information of vertices in the order they are visited.

**4.6.2.6 dfs()** [2/2]

```
template<class T >
std::vector< T > Graph< T >::dfs (
    const T & source ) const
```

Performs depth-first search traversal of the graph starting from a specific vertex.

**Parameters**

<i>source</i>	The information of the starting vertex.
---------------	---

**Returns**

A vector containing the information of vertices in the order they are visited.

**4.6.2.7 dfsVisit()**

```
template<class T >
void Graph< T >::dfsVisit (
    Vertex< T > * v,
    std::vector< T > & res ) const
```

Helper function for depth-first search traversal of the graph.

**Parameters**

<i>v</i>	The pointer to the current vertex being visited.
<i>res</i>	The vector to store the information of vertices in the order they are visited.

**4.6.2.8 EdgesAtDistanceDFS()**

```
template<class T >
std::vector< Edge< T > > Graph< T >::EdgesAtDistanceDFS (
    const T & source,
    int k )
```

Finds edges at a specific distance from a source vertex using depth-first search.

**Parameters**

<i>source</i>	The information of the source vertex.
<i>k</i>	The distance from the source vertex.

**Returns**

A vector containing the edges at the specified distance.

**4.6.2.9 findVertex()**

```
template<class T >
Vertex< T > * Graph< T >::findVertex (
    const T & in ) const
```

Finds a vertex with a given information in the graph.

**Parameters**

<i>in</i>	The information to search for in the vertices.
-----------	--

**Returns**

Pointer to the vertex with the given information, or nullptr if not found.

**4.6.2.10 getNumVertex()**

```
template<class T >
int Graph< T >::getNumVertex ( ) const
```

Gets the number of vertices in the graph.

**Returns**

The number of vertices in the graph.

**4.6.2.11 getVertexSet()**

```
template<class T >
std::vector< Vertex< T > * > Graph< T >::getVertexSet ( ) const
```

Gets the vector of vertices in the graph.

**Returns**

The vector of vertices in the graph.

**4.6.2.12 inDegree()**

```
template<class T >
void Graph< T >::inDegree (
    Vertex< T > * source )
```

Determines the in-degree of a specific vertex in the graph.

**Parameters**

<i>source</i>	The pointer to the vertex for which the in-degree is calculated.
---------------	--

**4.6.2.13 nodesAtDistanceDFS()**

```
template<class T >
std::vector< T > Graph< T >::nodesAtDistanceDFS (
    const T & source,
    int k )
```

Finds nodes at a specific distance from a source vertex using depth-first search.

**Parameters**

<i>source</i>	The information of the source vertex.
<i>k</i>	The distance from the source vertex.

**Returns**

A vector containing the information of vertices at the specified distance.

**4.6.2.14 removeEdge()**

```
template<class T >
bool Graph< T >::removeEdge (
```



```
const T & sourc,
const T & dest )
```

Removes the edge between vertices with source and destination information.

#### Parameters

<i>sourc</i>	The information of the source vertex.
<i>dest</i>	The information of the destination vertex.

#### Returns

True if the edge is removed successfully, false if the source or destination vertex is not found.

#### 4.6.2.15 removeVertex()

```
template<class T >
bool Graph< T >::removeVertex (
    const T & in )
```

Removes the vertex with the given information from the graph.

#### Parameters

<i>in</i>	The information of the vertex to be removed.
-----------	--

#### Returns

True if the vertex is removed successfully, false if the vertex is not found.

### 4.6.3 Member Data Documentation

#### 4.6.3.1 vertexSet

```
template<class T >
std::vector<Vertex<T> *> Graph< T >::vertexSet [private]
```

The vector of vertices in the graph.

The documentation for this class was generated from the following file:

- inc/[Graph.hpp](#)

## 4.7 Vertex< T > Class Template Reference

Represents a vertex in a graph with generic information of type T.

```
#include <Graph.hpp>
```

#### Public Member Functions

- [Vertex](#) (T in)  
*Constructor for creating a vertex with the given information.*
- T [getInfo](#) () const  
*Gets the information stored in the vertex.*
- void [setInfo](#) (T in)  
*Sets the information stored in the vertex.*
- bool [isVisited](#) () const  
*Checks if the vertex has been visited during graph traversal.*
- void [setVisited](#) (bool v)  
*Sets the visited status of the vertex.*

- bool `isProcessing` () const  
*Checks if the vertex is currently being processed during traversal.*
- void `setProcessing` (bool p)  
*Sets the processing status of the vertex.*
- void `setInDegree` (int i)  
*Sets the indegree of the vertex.*
- int `getInDegree` ()  
*Gets the indegree of the vertex.*
- int `getNum` () const  
*Gets the numeric identifier of the vertex.*
- void `setNum` (int num)  
*Sets the numeric identifier of the vertex.*
- int `getLow` () const  
*Gets the low value of the vertex.*
- void `setLow` (int low)  
*Sets the low value of the vertex.*
- int `getDistance` () const  
*Gets the distance of the vertex.*
- void `setDistance` (int distance)  
*Sets the distance of the vertex.*
- void `addEdge` (Vertex< T > \*d, std::string in, double w)  
*Adds an edge from this vertex to the specified destination vertex with a given weight.*
- bool `removeEdgeTo` (Vertex< T > \*d)  
*Removes the edge from this vertex to the specified destination vertex.*
- const std::vector< Edge< T > > & `getAdj` () const  
*Gets the vector of edges adjacent to this vertex.*
- void `setAdj` (const std::vector< Edge< T > > &adj\_vec)  
*Sets the vector of edges adjacent to this vertex.*

### Private Attributes

- T `info`
- std::vector< Edge< T > > `adj`
- bool `visited`
- bool `processing`
- int `indegree`
- int `num`
- int `low`
- int `distance`

### Friends

- class `Graph< T >`

## 4.7.1 Detailed Description

```
template<class T>
class Vertex< T >
```

Represents a vertex in a graph with generic information of type T.

### Template Parameters

<i>T</i>	The type of information stored in the vertex.
----------	---

## 4.7.2 Constructor & Destructor Documentation

### 4.7.2.1 Vertex()

```
template<class T >
Vertex< T >::Vertex (
    T in )
```

Constructor for creating a vertex with the given information.

#### Parameters

<i>in</i>	The information to be stored in the vertex.
-----------	---

## 4.7.3 Member Function Documentation

### 4.7.3.1 addEdge()

```
template<class T >
void Vertex< T >::addEdge (
    Vertex< T > * d,
    std::string in,
    double w )
```

Adds an edge from this vertex to the specified destination vertex with a given weight.

#### Parameters

<i>d</i>	The destination vertex.
<i>in</i>	The information associated with the edge.
<i>w</i>	The weight of the edge.

### 4.7.3.2 getAdj()

```
template<class T >
const std::vector< Edge< T > > & Vertex< T >::getAdj ( ) const
```

Gets the vector of edges adjacent to this vertex.

#### Returns

The vector of edges adjacent to this vertex.

### 4.7.3.3 getDistance()

```
template<class T >
int Vertex< T >::getDistance ( ) const
```

Gets the distance of the vertex.

#### Returns

The distance of the vertex.

### 4.7.3.4 getInDegree()

```
template<class T >
int Vertex< T >::getInDegree ( )
```

Gets the indegree of the vertex.

#### Returns

The indegree of the vertex.

#### 4.7.3.5 getInfo()

```
template<class T >
T Vertex< T >::getInfo ( ) const
Gets the information stored in the vertex.
```

##### Returns

The information stored in the vertex.

#### 4.7.3.6 getLow()

```
template<class T >
int Vertex< T >::getLow ( ) const
Gets the low value of the vertex.
```

##### Returns

The low value of the vertex.

#### 4.7.3.7 getNum()

```
template<class T >
int Vertex< T >::getNum ( ) const
Gets the numeric identifier of the vertex.
```

##### Returns

The numeric identifier of the vertex.

#### 4.7.3.8 isProcessing()

```
template<class T >
bool Vertex< T >::isProcessing ( ) const
Checks if the vertex is currently being processed during traversal.
```

##### Returns

True if the vertex is being processed, false otherwise.

#### 4.7.3.9 isVisited()

```
template<class T >
bool Vertex< T >::isVisited ( ) const
Checks if the vertex has been visited during graph traversal.
```

##### Returns

True if the vertex has been visited, false otherwise.

#### 4.7.3.10 removeEdgeTo()

```
template<class T >
bool Vertex< T >::removeEdgeTo (
    Vertex< T > * d )
Removes the edge from this vertex to the specified destination vertex.
```

##### Parameters

<i>d</i>	The destination vertex.
----------	-------------------------

**Returns**

True if the edge was successfully removed, false otherwise.

**4.7.3.11 setAdj()**

```
template<class T >
void Vertex< T >::setAdj (
    const std::vector< Edge< T > > & adj_vec )
```

Sets the vector of edges adjacent to this vertex.

**Parameters**

<i>adj_vec</i>	The new vector of edges adjacent to this vertex.
----------------	--

**4.7.3.12 setDistance()**

```
template<class T >
void Vertex< T >::setDistance (
    int distance )
```

Sets the distance of the vertex.

**Parameters**

<i>distance</i>	The new distance of the vertex.
-----------------	---------------------------------

**4.7.3.13 setInDegree()**

```
template<class T >
void Vertex< T >::setInDegree (
    int i )
```

Sets the indegree of the vertex.

**Parameters**

<i>i</i>	The new indegree of the vertex.
----------	---------------------------------

**4.7.3.14 setInfo()**

```
template<class T >
void Vertex< T >::setInfo (
    T in )
```

Sets the information stored in the vertex.

**Parameters**

<i>in</i>	The new information to be stored in the vertex.
-----------	---

**4.7.3.15 setLow()**

```
template<class T >
void Vertex< T >::setLow (
    int low )
```

Sets the low value of the vertex.

**Parameters**

<i>low</i>	The new low value.
------------	--------------------

**4.7.3.16 setNum()**

```
template<class T >
void Vertex< T >::setNum (
    int num )
```

Sets the numeric identifier of the vertex.

**Parameters**

<i>num</i>	The new numeric identifier.
------------	-----------------------------

**4.7.3.17 setProcessing()**

```
template<class T >
void Vertex< T >::setProcessing (
    bool p )
```

Sets the processing status of the vertex.

**Parameters**

<i>p</i>	The new processing status.
----------	----------------------------

**4.7.3.18 setVisited()**

```
template<class T >
void Vertex< T >::setVisited (
    bool v )
```

Sets the visited status of the vertex.

**Parameters**

<i>v</i>	The new visited status.
----------	-------------------------

**4.7.4 Friends And Related Symbol Documentation****4.7.4.1 Graph< T >**

```
template<class T >
friend class Graph< T > [friend]
```

**4.7.5 Member Data Documentation****4.7.5.1 adj**

```
template<class T >
std::vector<Edge<T> > Vertex< T >::adj [private]
```

The vector of edges adjacent to this vertex.

**4.7.5.2 distance**

```
template<class T >
```

```
int Vertex< T >::distance [private]
```

Distance of the vertex in certain graph traversal algorithms.

#### 4.7.5.3 indegree

```
template<class T >
```

```
int Vertex< T >::indegree [private]
```

The indegree of the vertex in a directed graph.

#### 4.7.5.4 info

```
template<class T >
```

```
T Vertex< T >::info [private]
```

The information stored in the vertex.

#### 4.7.5.5 low

```
template<class T >
```

```
int Vertex< T >::low [private]
```

Low value used in Tarjan's algorithm for finding strongly connected components.

#### 4.7.5.6 num

```
template<class T >
```

```
int Vertex< T >::num [private]
```

Numeric identifier for the vertex.

#### 4.7.5.7 processing

```
template<class T >
```

```
bool Vertex< T >::processing [private]
```

Flag indicating if the vertex is currently being processed during traversal.

#### 4.7.5.8 visited

```
template<class T >
```

```
bool Vertex< T >::visited [private]
```

Flag indicating if the vertex has been visited during graph traversal.

The documentation for this class was generated from the following file:

- [inc/Graph.hpp](#)





# Chapter 5

## File Documentation

### 5.1 inc/Airline.hpp File Reference

```
#include <string>
```

#### Classes

- class [Airline](#)

*Represents an airline with specific attributes such as code, name, callsign, and country.*

### 5.2 Airline.hpp

[Go to the documentation of this file.](#)

```
00001 #ifndef AIRLINE_H
00002 #define AIRLINE_H
00003
00004 #include <string>
00005
00009 class Airline
00010 {
00012     std::string code;
00013
00015     std::string name;
00016
00018     std::string callsign;
00019
00021     std::string country;
00022
00023 public:
00031     Airline(const std::string code, const std::string name, const std::string callsign, const
std::string country);
00032
00037     Airline(const std::string &code);
00038
00043     std::string getCode() const;
00044
00049     void setCode(const std::string &c);
00050
00055     std::string getName() const;
00056
00061     void setName(const std::string &n);
00062
00067     std::string getCallsign() const;
00068
00073     void setCallsign(const std::string &c);
00074
00079     std::string getCountry() const;
00080
00085     void setCountry(const std::string &c);
00086 };
00087
00088 #endif
```

## 5.3 inc/Airport.hpp File Reference

```
#include <string>
#include <utility>
```

### Classes

- class [Airport](#)

*Represents an airport with attributes such as code, name, city, country, and position.*

## 5.4 Airport.hpp

[Go to the documentation of this file.](#)

```
00001 #ifndef AIRPORT_H
00002 #define AIRPORT_H
00003
00004 #include <string>
00005 #include <utility>
00006
00010 class Airport
00011 {
00013     std::string code;
00014
00016     std::string name;
00017
00019     std::string city;
00020
00022     std::string country;
00023
00025     std::pair<float, float> position;
00026
00027 public:
00036     Airport(const std::string &code, const std::string &name, const std::string &city,
00037             const std::string &country, const std::pair<float, float> &position);
00038
00043     Airport(const std::string &code);
00044
00049     std::string getCode() const;
00050
00055     void setCode(const std::string &c);
00056
00061     std::string getName() const;
00062
00067     void setName(const std::string &n);
00068
00073     std::string getCity() const;
00074
00079     void setCity(const std::string &c);
00080
00085     std::string getCountry() const;
00086
00091     void setCountry(const std::string &c);
00092
00097     std::pair<float, float> getPosition() const;
00098
00103     void setPosition(const std::pair<float, float> &pos);
00104
00110     bool operator==(const Airport &other);
00111
00117     bool operator<(const Airport &other);
00118 };
00119
00120 #endif
```

## 5.5 inc/App.hpp File Reference

```
#include "FlightNetwork.hpp"
#include <cstdlib>
```

### Classes

- class [App](#)

## Functions

- void [clearScreen](#) ()

## 5.5.1 Function Documentation

### 5.5.1.1 clearScreen()

```
void clearScreen ( )
```

## 5.6 App.hpp

[Go to the documentation of this file.](#)

```
00001 #ifndef APP_H
00002 #define APP_H
00003
00004 #include "FlightNetwork.hpp"
00005 #include <cstdlib>
00006
00007 void clearScreen();
00008
00009 class App
00010 {
00011     FlightNetwork flightnetwork;
00012
00013 public:
00014     App(FlightNetwork &flightnetwork);
00015     void mainMenu();
00016
00017     void statisticsMenu();
00018     void bestFlightMenu();
00019     void goBackStatisticsMenu();
00020     void globalStatistics();
00021     void showNumFlights();
00022     void numberOfDestinations(Airport &airport);
00023     void reachableDest(Airport &airport, int stops);
00024
00025 };
00026
00027 #endif
```

## 5.7 inc/FlightNetwork.hpp File Reference

```
#include "Airline.hpp"
#include "Airport.hpp"
#include "Graph.hpp"
#include <iostream>
#include <fstream>
#include <sstream>
#include <set>
#include <stack>
#include <cmath>
#include <tuple>
#include <functional>
#include <limits>
```

## Classes

- class [FlightNetwork](#)  
*Represents a flight network consisting of airports and flights.*

## Functions

- void [dfs\\_art](#) (Graph< [Airport](#) > &g, Vertex< [Airport](#) > \*v, set< string > &l, int &i)  
*Depth-first search for identifying articulation points in the airport graph.*

- double [haversineDistance](#) (double lat1, double lon1, double lat2, double lon2)  
*Calculates the Haversine distance between two geographical points.*

## 5.7.1 Function Documentation

### 5.7.1.1 dfs\_art()

```
void dfs_art (
    Graph< Airport > & g,
    Vertex< Airport > * v,
    set< string > & l,
    int & i )
```

Depth-first search for identifying articulation points in the airport graph.

#### Parameters

<i>g</i>	The airport graph.
<i>v</i>	The current vertex in the DFS traversal.
<i>l</i>	Set to store the identified articulation points.
<i>i</i>	Reference to the current DFS iteration number.

### 5.7.1.2 haversineDistance()

```
double haversineDistance (
    double lat1,
    double lon1,
    double lat2,
    double lon2 )
```

Calculates the Haversine distance between two geographical points.

#### Parameters

<i>lat1</i>	Latitude of the first point.
<i>lon1</i>	Longitude of the first point.
<i>lat2</i>	Latitude of the second point.
<i>lon2</i>	Longitude of the second point.

#### Returns

Haversine distance between the two points.

## 5.8 FlightNetwork.hpp

[Go to the documentation of this file.](#)

```
00001 #ifndef FLIGHT_NETWORK_H
00002 #define FLIGHT_NETWORK_H
00003
00004 #include "Airline.hpp"
00005 #include "Airport.hpp"
00006 #include "Graph.hpp"
00007 #include <iostream>
00008 #include <fstream>
00009 #include <sstream>
00010 #include <set>
00011 #include <stack>
00012 #include <cmath>
00013 #include <tuple>
00014 #include <functional>
00015 #include <limits>
00016
00020 class FlightNetwork
```

```

00021 {
00025     Graph<Airport> airportsGraph;
00026
00027 public:
00031     FlightNetwork();
00032
00040     FlightNetwork(const std::string &airlines_filename, const std::string &airports_filename, const
std::string &flights_filename);
00041
00047     Graph<Airport> getAiportsGraph();
00048
00054     int getGlobalNumOfAirports() const; // 3) i.
00055
00061     int getGlobalNumOfFlights() const; // 3) i.
00062
00069     std::pair<int, int> numFlightsAirport(const Airport &airport); // 3) ii.
00070
00077     int numFlightsCity(const std::string &city) const; // 3) iii.
00078
00085     int numFlightsAirline(Airline &airline) const; // 3) iii.
00086
00093     std::set<std::string> getDiffCountriesAirport(const Airport &airport) const; // 3) iv.
00094
00101     std::set<std::string> getDiffCountriesCity(const std::string &city) const; // 3) iv.
00102
00109     std::set<std::string> getAirportsDestinations(const Airport &airport) const; // 3) v.
00110
00117     std::set<std::string> getCitiesDestinations(const Airport &airport) const; // 3) v.
00118
00125     std::set<std::string> getCountriesDestinations(const Airport &airport) const; // 3) v.
00126
00134     std::set<std::string> getReachableAirports(const Airport &airport, const int &distance); // 3) vi.
00135
00143     std::set<std::string> getReachableCities(const Airport &airport, const int &distance); // 3) vi.
00144
00152     std::set<std::string> getReachableCountries(const Airport &airport, const int &distance); // 3)
vi.
00153
00160     int maximumTrip(std::vector<std::pair<std::string, std::string> &airports); // 3) vii.
00161
00168     std::set<std::string> getGreatestTraffic(const int &k); // 3) viii.
00169
00175     std::set<std::string> getEssentialAirports(); // 3) ix.
00176
00184     Airport codeCriteria(const std::string &code) const; // 4) i.
00185
00193     Airport nameCriteria(const std::string &name) const; // 4) i.
00194
00202     std::vector<Airport> cityCriteria(const std::string &city) const; // 4) ii.
00203
00212     std::vector<Airport> coordinateCriteria(const float &lat, const float &lon) const; // 4) iii.
00213
00223     std::vector<vector<Airport>> bestFlight(const Airport &source, const Airport &destination, const
set<string> &allowedAirlines = {}, bool minimizeAirlines = false) const; // 4)
00224
00234     std::vector<std::vector<Airport>> listBestFlights(const int &flag1, const int &flag2, const
set<string> &allowedAirlines, bool minimizeAirlines) const;
00235
00245     std::string airportCodeToName(const std::string &code);
00246
00256     std::string airlineCodeToName(const std::string &code);
00257 };
00258
00267 void dfs_art(Graph<Airport> &g, Vertex<Airport> *v, set<string> &l, int &i);
00268
00278 double haversineDistance(double lat1, double lon1, double lat2, double lon2);
00279
00280 #endif

```

## 5.9 inc/Graph.hpp File Reference

```

#include <string>
#include <vector>
#include <queue>
#include <unordered_map>

```

### Classes

- class [Vertex< T >](#)

*Represents a vertex in a graph with generic information of type T.*

- class [Edge< T >](#)

*Represents an edge between two vertices in a graph with generic information of type T.*

- class [Graph< T >](#)

*Represents a generic graph with vertices of type T.*

## Functions

- template<class T >  
void [nodesAtDistanceDFSVisit](#) ([Vertex](#)< T > \*v, int k, std::vector< T > &res)
- template<class T >  
void [nodesAtDistanceDFSVisit](#) ([Vertex](#)< T > \*v, int k, std::vector< [Edge](#)< T > > &res)

## 5.9.1 Function Documentation

### 5.9.1.1 nodesAtDistanceDFSVisit() [1/2]

```
template<class T >
void nodesAtDistanceDFSVisit (
    Vertex< T > * v,
    int k,
    std::vector< Edge< T > > & res )
```

### 5.9.1.2 nodesAtDistanceDFSVisit() [2/2]

```
template<class T >
void nodesAtDistanceDFSVisit (
    Vertex< T > * v,
    int k,
    std::vector< T > & res )
```

## 5.10 Graph.hpp

[Go to the documentation of this file.](#)

```
00001 #ifndef GRAPH_H
00002 #define GRAPH_H
00003
00004 #include <string>
00005 #include <vector>
00006 #include <queue>
00007 #include <unordered_map>
00008 using namespace std;
00009
00010 template <class T>
00011 class Edge;
00012
00013 template <class T>
00014 class Graph;
00015
00016 template <class T>
00017 class Vertex;
00018
00023 template <class T>
00024 class Vertex
00025 {
00027     T info;
00028
00030     std::vector<Edge<T> > adj;
00031
00033     bool visited;
00034
00036     bool processing;
00037
00039     int indegree;
00040
00042     int num;
00043
00045     int low;
00046
00048     int distance;
```

```

00049
00050 public:
00051     Vertex(T in);
00052
00053     T getInfo() const;
00054
00055     void setInfo(T in);
00056
00057     bool isVisited() const;
00058
00059     void setVisited(bool v);
00060
00061     bool isProcessing() const;
00062
00063     void setProcessing(bool p);
00064
00065     void setInDegree(int i);
00066
00067     int getInDegree();
00068
00069     int getNum() const;
00070
00071     void setNum(int num);
00072
00073     int getLow() const;
00074
00075     void setLow(int low);
00076
00077     int getDistance() const;
00078
00079     void setDistance(int distance);
00080
00081     void addEdge(Vertex<T> *d, std::string in, double w);
00082
00083     bool removeEdgeTo(Vertex<T> *d);
00084
00085     const std::vector<Edge<T>> &getAdj() const;
00086
00087     void setAdj(const std::vector<Edge<T>> &adj_vec);
00088
00089     friend class Graph<T>; // Allow Graph class to access private members of Vertex.
00090 };
00091
00092 template <class T>
00093 class Edge
00094 {
00095     Vertex<T> *dest;
00096
00097     std::string info;
00098
00099     double weight;
00100
00101 public:
00102     Edge(Vertex<T> *d, std::string in, double w);
00103
00104     Vertex<T> *getDest() const;
00105
00106     void setDest(Vertex<T> *d);
00107
00108     std::string getInfo() const;
00109
00110     void setInfo(std::string in);
00111
00112     double getWeight() const;
00113
00114     void setWeight(double weight);
00115
00116     friend class Graph<T>;
00117     friend class Vertex<T>;
00118 };
00119
00120 template <class T>
00121 class Graph
00122 {
00123     std::vector<Vertex<T>> * vertexSet;
00124
00125 public:
00126     Vertex<T> *findVertex(const T &in) const;
00127
00128     int getNumVertex() const;
00129
00130     bool addVertex(const T &in);
00131
00132     bool removeVertex(const T &in);
00133
00134     bool addEdge(const T &source, const T &dest, const std::string &in, double w);
00135
00136
00137
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00143
00144
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```

```

00291     bool removeEdge(const T &source, const T &dest);
00292
00297     std::vector<Vertex<T> *> getVertexSet() const;
00298
00304     void dfsVisit(Vertex<T> *v, std::vector<T> &res) const;
00305
00310     std::vector<T> dfs() const;
00311
00317     std::vector<T> dfs(const T &source) const;
00318
00325     std::vector<T> nodesAtDistanceDFS(const T &source, int k);
00326
00333     std::vector<Edge<T> > EdgesAtDistanceDFS(const T &source, int k);
00334
00340     std::vector<T> bfs(const T &source) const;
00341
00348     std::vector<std::pair<int, T> > bfsDistance(Vertex<T> *source);
00349
00354     void inDegree(Vertex<T> *source);
00355 };
00356
00357 /*
00358     Vertex functions
00359 */
00360
00361 template <class T>
00362 Vertex<T>::Vertex(T in) : info(in), visited(false), processing(false) {}
00363
00364 template <class T>
00365 T Vertex<T>::getInfo() const
00366 {
00367     return info;
00368 }
00369
00370 template <class T>
00371 void Vertex<T>::setInfo(T in)
00372 {
00373     info = in;
00374 }
00375
00376 template <class T>
00377 bool Vertex<T>::isVisited() const
00378 {
00379     return visited;
00380 }
00381
00382 template <class T>
00383 void Vertex<T>::setVisited(bool v)
00384 {
00385     visited = v;
00386 }
00387
00388 template <class T>
00389 bool Vertex<T>::isProcessing() const
00390 {
00391     return processing;
00392 }
00393
00394 template <class T>
00395 void Vertex<T>::setProcessing(bool p)
00396 {
00397     processing = p;
00398 }
00399
00400 template <class T>
00401 void Vertex<T>::setInDegree(int i)
00402 {
00403     indegree = i;
00404 }
00405
00406 template <class T>
00407 int Vertex<T>::getInDegree()
00408 {
00409     return indegree;
00410 }
00411
00412 template <class T>
00413 int Vertex<T>::getNum() const
00414 {
00415     return num;
00416 }
00417
00418 template <class T>
00419 void Vertex<T>::setNum(int num)
00420 {
00421     Vertex::num = num;
00422 }

```



```

00423
00424 template <class T>
00425 int Vertex<T>::getLow() const
00426 {
00427     return low;
00428 }
00429
00430 template <class T>
00431 void Vertex<T>::setDistance(int distance)
00432 {
00433     Vertex::distance = distance;
00434 }
00435
00436 template <class T>
00437 int Vertex<T>::getDistance() const
00438 {
00439     return distance;
00440 }
00441
00442 template <class T>
00443 void Vertex<T>::setLow(int low)
00444 {
00445     Vertex::low = low;
00446 }
00447
00448 template <class T>
00449 void Vertex<T>::addEdge(Vertex<T> *d, std::string in, double w)
00450 {
00451     adj.push_back(Edge<T>(d, in, w));
00452 }
00453
00454 template <class T>
00455 bool Vertex<T>::removeEdgeTo(Vertex<T> *d)
00456 {
00457     for (auto it = adj.begin(); it != adj.end(); it++)
00458         if (it->dest == d)
00459             {
00460                 adj.erase(it);
00461                 return true;
00462             }
00463     return false;
00464 }
00465
00466 template <class T>
00467 const std::vector<Edge<T>> &Vertex<T>::getAdj() const
00468 {
00469     return adj;
00470 }
00471
00472 template <class T>
00473 void Vertex<T>::setAdj(const std::vector<Edge<T>> &adj_vec)
00474 {
00475     adj = adj_vec;
00476 }
00477
00478 /*
00479     Edge functions
00480 */
00481
00482 template <class T>
00483 Edge<T>::Edge(Vertex<T> *d, std::string in, double w) : dest(d), info(in), weight(w) {}
00484
00485 template <class T>
00486 Vertex<T> *Edge<T>::getDest() const
00487 {
00488     return dest;
00489 }
00490
00491 template <class T>
00492 void Edge<T>::setDest(Vertex<T> *d)
00493 {
00494     dest = d;
00495 }
00496
00497 template <class T>
00498 std::string Edge<T>::getInfo() const
00499 {
00500     return info;
00501 }
00502
00503 template <class T>
00504 void Edge<T>::setInfo(std::string in)
00505 {
00506     info = in;
00507 }
00508
00509 template <class T>

```

```

00510 double Edge<T>::getWeight() const
00511 {
00512     return weight;
00513 }
00514
00515 template <class T>
00516 void Edge<T>::setWeight(double weight)
00517 {
00518     Edge::weight = weight;
00519 }
00520
00521 /*
00522     Graph functions
00523 */
00524
00525 template <class T>
00526 Vertex<T> *Graph<T>::findVertex(const T &in) const
00527 {
00528     for (auto v : vertexSet)
00529         if (v->info == in)
00530             return v;
00531     return NULL;
00532 }
00533
00534 template <class T>
00535 int Graph<T>::getNumVertex() const
00536 {
00537     return vertexSet.size();
00538 }
00539
00540 template <class T>
00541 bool Graph<T>::addVertex(const T &in)
00542 {
00543     if (findVertex(in) != NULL)
00544         return false;
00545     vertexSet.push_back(new Vertex<T>(in));
00546     return true;
00547 }
00548
00549 template <class T>
00550 bool Graph<T>::removeVertex(const T &in)
00551 {
00552     for (auto it = vertexSet.begin(); it != vertexSet.end(); it++)
00553         if ((*it)->info == in)
00554         {
00555             auto v = *it;
00556             vertexSet.erase(it);
00557             for (auto u : vertexSet)
00558                 u->removeEdgeTo(v);
00559             delete v;
00560             return true;
00561         }
00562     return false;
00563 }
00564
00565 template <class T>
00566 bool Graph<T>::addEdge(const T &sourc, const T &dest, const std::string &in, double w)
00567 {
00568     auto v1 = findVertex(sourc);
00569     auto v2 = findVertex(dest);
00570     if (v1 == NULL || v2 == NULL)
00571         return false;
00572     v1->addEdge(v2, in, w);
00573     return true;
00574 }
00575
00576 template <class T>
00577 bool Graph<T>::removeEdge(const T &sourc, const T &dest)
00578 {
00579     auto v1 = findVertex(sourc);
00580     auto v2 = findVertex(dest);
00581     if (v1 == NULL || v2 == NULL)
00582         return false;
00583     return v1->removeEdgeTo(v2);
00584 }
00585
00586 template <class T>
00587 std::vector<Vertex<T>*> Graph<T>::getVertexSet() const
00588 {
00589     return vertexSet;
00590 }
00591
00592 template <class T>
00593 void Graph<T>::dfsVisit(Vertex<T> *v, std::vector<T> &res) const
00594 {
00595     v->setVisited(true);
00596     res.push_back(v->getInfo());

```

```

00597
00598     for (const Edge<T> &edge : v->getAdj())
00599     {
00600         Vertex<T> *neighbor = edge.getDest();
00601
00602         if (!neighbor->isVisited())
00603         {
00604             dfsVisit(neighbor, res);
00605         }
00606     }
00607 }
00608
00609 template <class T>
00610 std::vector<T> Graph<T>::dfs() const
00611 {
00612     std::vector<T> res;
00613
00614     for (Vertex<T> *v : vertexSet)
00615     {
00616         if (!v->isVisited())
00617         {
00618             dfsVisit(v, res);
00619         }
00620     }
00621
00622     for (Vertex<T> *v : vertexSet)
00623     {
00624         v->setVisited(false);
00625     }
00626
00627     return res;
00628 }
00629
00630 template <class T>
00631 std::vector<T> Graph<T>::dfs(const T &source) const
00632 {
00633     std::vector<T> res;
00634     res.push_back(source);
00635
00636     Vertex<T> *source_vertex = findVertex(source);
00637     source_vertex->setVisited(true);
00638
00639     for (const Edge<T> &e : source_vertex->getAdj())
00640     {
00641         Vertex<T> *neighbor = e.getDest();
00642
00643         if (!neighbor->isVisited())
00644             dfsVisit(neighbor, res);
00645     }
00646
00647     for (Vertex<T> *vtx : vertexSet)
00648     {
00649         vtx->setVisited(false);
00650     }
00651
00652     return res;
00653 }
00654
00655 template <class T>
00656 std::vector<T> Graph<T>::nodesAtDistanceDFS(const T &source, int k)
00657 {
00658     std::vector<T> res;
00659     Vertex<T> *aux;
00660
00661     for (auto v : vertexSet)
00662     {
00663         v->setVisited(false);
00664     }
00665
00666     aux = this->findVertex(source);
00667
00668     nodesAtDistanceDFSVisit(aux, k, res);
00669
00670     return res;
00671 }
00672
00673 template <class T>
00674 void nodesAtDistanceDFSVisit(Vertex<T> *v, int k, std::vector<T> &res)
00675 {
00676     v->setVisited(true);
00677     if (k == 0)
00678     {
00679         res.push_back(v->getInfo());
00680         return;
00681     }
00682     for (Edge<T> e : v->getAdj())
00683     {

```

```

00684         auto w = e.getDest();
00685         if (!w->isVisited())
00686         {
00687             nodesAtDistanceDFSVisit(w, k - 1, res);
00688         }
00689     }
00690 }
00691
00692 template <class T>
00693 void nodesAtDistanceDFSVisit(Vertex<T> *v, int k, std::vector<Edge<T>> &res)
00694 {
00695     v->setVisited(true);
00696     if (k == 0)
00697     {
00698         for (auto aux : v->getAdj())
00699         {
00700             res.push_back(aux);
00701         }
00702         return;
00703     }
00704     for (Edge<T> e : v->getAdj())
00705     {
00706         auto w = e.getDest();
00707         if (!w->isVisited())
00708         {
00709             nodesAtDistanceDFSVisit(w, k - 1, res);
00710         }
00711     }
00712 }
00713
00714 template <class T>
00715 std::vector<Edge<T>> Graph<T>::EdgesAtDistanceDFS(const T &source, int k)
00716 {
00717     std::vector<Edge<T>> res;
00718     Vertex<T> *aux;
00719
00720     for (auto v : vertexSet)
00721     {
00722         v->setVisited(false);
00723     }
00724
00725     aux = this->findVertex(source);
00726
00727     nodesAtDistanceDFSVisit(aux, k, res);
00728
00729     return res;
00730 }
00731
00732 template <class T>
00733 std::vector<T> Graph<T>::bfs(const T &source) const
00734 {
00735     std::vector<T> res;
00736     std::queue<Vertex<T>*> aux;
00737
00738     for (Vertex<T> *v : vertexSet)
00739         v->setVisited(false);
00740
00741     Vertex<T> *source_vertex = findVertex(source);
00742     source_vertex->setVisited(true);
00743     aux.push(source_vertex);
00744
00745     while (!aux.empty())
00746     {
00747         Vertex<T> *curr = aux.front();
00748         aux.pop();
00749         res.push_back(curr->getInfo());
00750
00751         for (const Edge<T> &e : curr->getAdj())
00752         {
00753             Vertex<T> *neighbor = e.getDest();
00754             if (!neighbor->isVisited())
00755             {
00756                 neighbor->setVisited(true);
00757                 aux.push(neighbor);
00758             }
00759         }
00760     }
00761
00762     return res;
00763 }
00764
00765 template <class T>
00766 std::vector<std::pair<int, T>> Graph<T>::bfsDistance(Vertex<T> *source)
00767 {
00768     std::vector<std::pair<int, T>> res;
00769     std::queue<Vertex<T>*> aux;
00770

```

```

00771     for (Vertex<T> *v : vertexSet)
00772     {
00773         v->setVisited(false);
00774         v->setDistance(10000);
00775     }
00776
00777     source->setVisited(true);
00778     source->setDistance(0);
00779     aux.push(source);
00780
00781     while (!aux.empty())
00782     {
00783         Vertex<T> *curr = aux.front();
00784         aux.pop();
00785         res.push_back({curr->getDistance(), curr->getInfo()});
00786
00787         for (const Edge<T> &e : curr->getAdj())
00788         {
00789             Vertex<T> *neighbor = e.getDest();
00790             if (!neighbor->isVisited())
00791             {
00792                 neighbor->setVisited(true);
00793                 neighbor->setDistance(curr->getDistance() + 1);
00794                 aux.push(neighbor);
00795             }
00796         }
00797     }
00798
00799     return res;
00800 }
00801 template <class T>
00802 void Graph<T>::inDegree(Vertex<T> *source)
00803 {
00804     int res = 0;
00805     if (source == NULL)
00806         return;
00807
00808     for (auto it = vertexSet.begin(); it != vertexSet.end(); ++it)
00809     {
00810         Vertex<T> *aux = *it;
00811         std::vector<Edge<T>> adj = aux->getAdj();
00812         for (auto ed : adj)
00813         {
00814             if (ed.getDest() == source)
00815                 res++;
00816         }
00817     }
00818     source->setInDegree(res);
00819 }
00820
00821 #endif

```

## 5.11 README.md File Reference

## 5.12 src/Airline.cpp File Reference

```
#include "../inc/Airline.hpp"
```

## 5.13 src/Airport.cpp File Reference

```
#include "../inc/Airport.hpp"
```

## 5.14 src/App.cpp File Reference

```
#include "../inc/App.hpp"
```

### Functions

- void `clearScreen` ()

### 5.14.1 Function Documentation

#### 5.14.1.1 clearScreen()

```
void clearScreen ( )
```

## 5.15 src/FlightNetwork.cpp File Reference

```
#include "../inc/FlightNetwork.hpp"
#include <limits.h>
```

### Functions

- double [haversineDistance](#) (double lat1, double lon1, double lat2, double lon2)  
*Calculates the Haversine distance between two geographical points.*
- void [dfs\\_art](#) (Graph< [Airport](#) > &g, Vertex< [Airport](#) > \*v, set< string > &l, int &i)  
*Depth-first search for identifying articulation points in the airport graph.*

### 5.15.1 Function Documentation

#### 5.15.1.1 dfs\_art()

```
void dfs_art (
    Graph< Airport > & g,
    Vertex< Airport > * v,
    set< string > & l,
    int & i )
```

Depth-first search for identifying articulation points in the airport graph.

#### Parameters

<i>g</i>	The airport graph.
<i>v</i>	The current vertex in the DFS traversal.
<i>l</i>	Set to store the identified articulation points.
<i>i</i>	Reference to the current DFS iteration number.

#### 5.15.1.2 haversineDistance()

```
double haversineDistance (
    double lat1,
    double lon1,
    double lat2,
    double lon2 )
```

Calculates the Haversine distance between two geographical points.

#### Parameters

<i>lat1</i>	Latitude of the first point.
<i>lon1</i>	Longitude of the first point.
<i>lat2</i>	Latitude of the second point.
<i>lon2</i>	Longitude of the second point.

### Returns

Haversine distance between the two points.

## 5.16 src/main.cpp File Reference

```
#include "../inc/Airline.hpp"
#include "../inc/Airport.hpp"
#include "../inc/Graph.hpp"
#include "../inc/FlightNetwork.hpp"
#include "../inc/App.hpp"
```

### Functions

- int [main](#) ()

### 5.16.1 Function Documentation

#### 5.16.1.1 main()

```
int main ( )
```





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