Shortest Flight Paths

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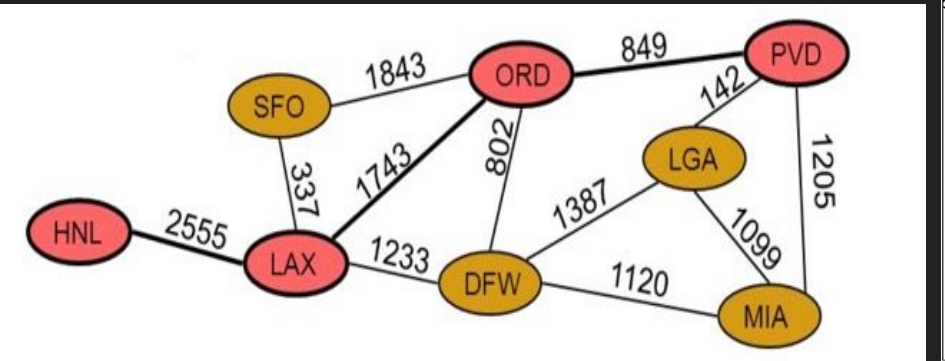
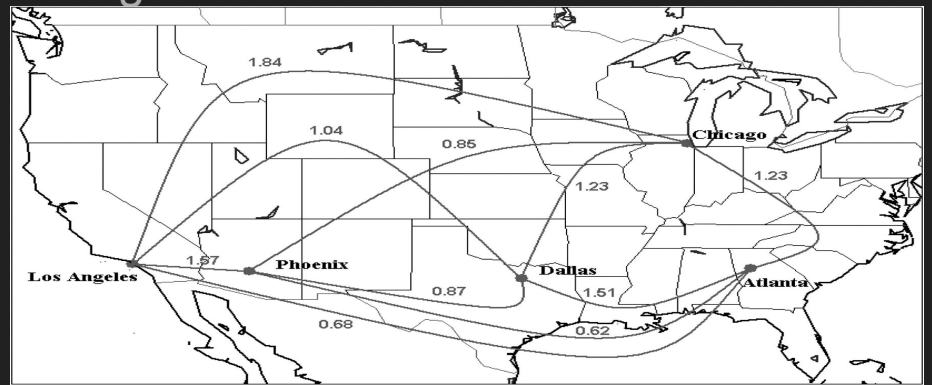
Goals and Summary

This program implements graph-based traversal algorithms on the OpenFlights airport and routes datasets in C++. https://openflights.org/data.html

Goals: Load the airports.txt and routes.txt into a Graph. Find the shortest flight routes between two airports. Traveling paths include Dijkstra, Landmark, and Breadth-First Search (BFS) to help users travel to other places in the world.

We accomplished DFS which was beyond our goals as well.





```
32          std:: cout << "\nType 0, 1, 2, 3, or 4 for the following:\n
33          std::cout << std::endl;
34          std::cin >> input;
35          std::cout << std::endl;
36
37          if (input == 0) { // Calls BFS Traversal
38              // Can be commented out for long textfiles.
39              std::cout << "BFS Traversal: " << o.pathToString(algo.B
40          } else if (input == 1) { // Calls DFS Traversal
41              // Can be commented out for long textfiles.
42              std::cout << "DFS Traversal: " << o.pathToString(algo.D
43          } else if (input == 2) { // Calls Dijkstra's Algorithm
44              std::cout << "Input starting AirportID: ";
45              std::cin >> start;
46              std::cout << o.getAllAirportData(start) << std::endl;
47              std::cout << std::endl;
48
```

Interface

```
[rvasant2@siebl-0224-28 finalproject]$ ./main
Welcome to a Graph-Based implementation of Breadth First Traversal (BFS), Depth F
rst Search (DFS), Dijkstra's Algorithm, and Landmark Path for the OpenFlights dat
set.

Authors (listed alphabetically): Alaa Shuaibi (ashuai6), Chidambara Anagani (cana
a2), Praneeth Mekapati (pm14), and Rahul Vasanth (rvasant2)

Input the name of your (properly formatted) Airports file: airports.txt
Input the name of your (properly formatted) Routes file: routes.txt


Type 0, 1, 2, 3, or 4 for the following:
0 - BFS
1 - DFS
2 - Dijkstra's Algorithm
3 - Landmark Path
4 - Input New File
```

UI

PROBLEMS OUTPUT TERMINAL 1: main Talking:

BFS and DFS

```
0 - BFS
1 - DFS
2 - Dijkstra's Algorithm
3 - Landmark Path
4 - Input New File

1

DFS Traversal: "University of Illinois Willard Airport" -> "Chicago O'Hare Interna
tional Airport" -> "San Francisco International Airport"

Type 0, 1, 2, 3, or 4 for the following:
0 - BFS
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0

BFS Traversal: "University of Illinois Willard Airport" -> "Chicago O'Hare Interna
tional Airport" -> "San Francisco International Airport"
```
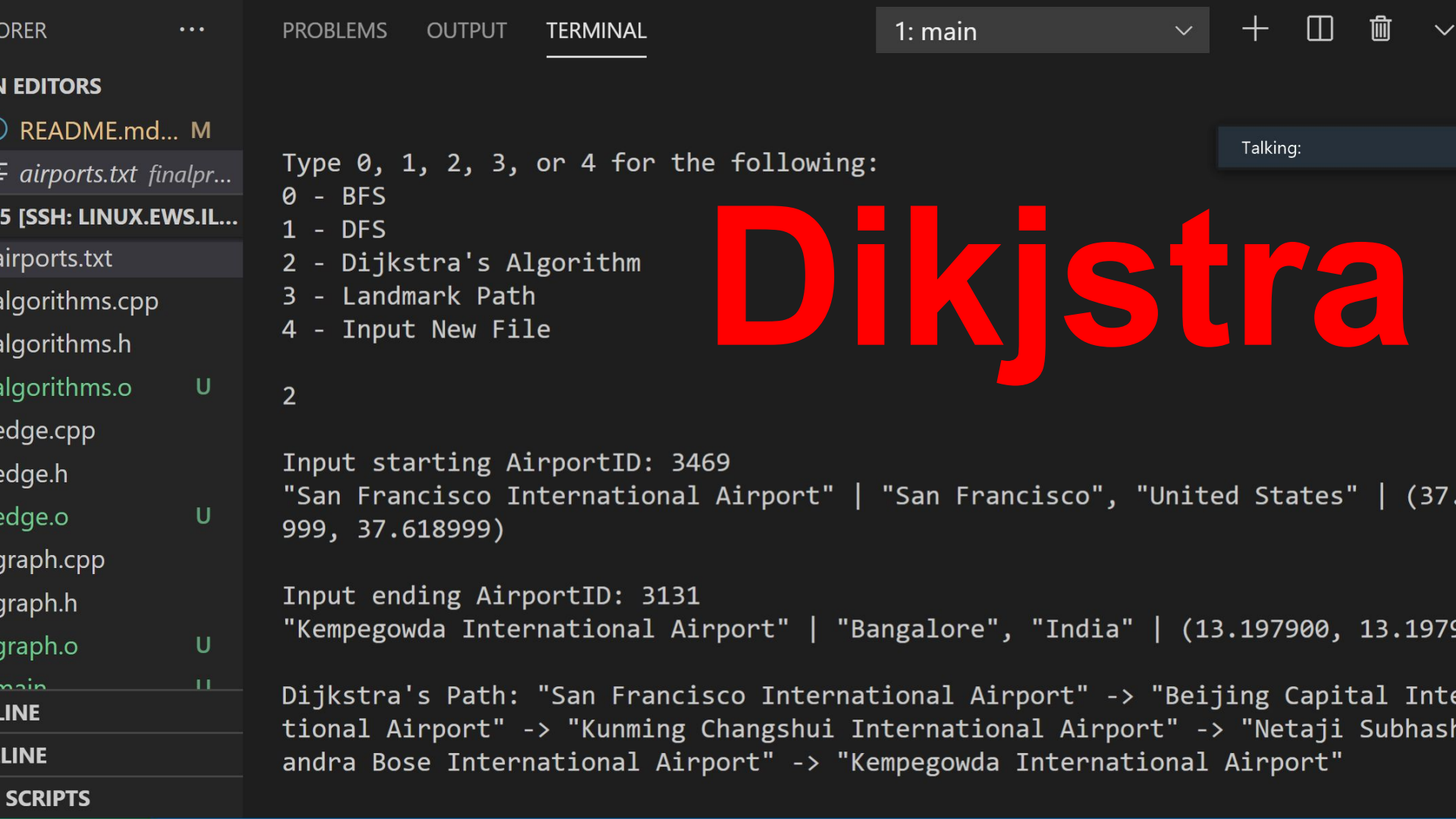

This is for the smaller datasets. For the full set we traverse through the entire graph with a runtime of 1min 24


PROBLEMS
OUTPUT
TERMINAL
1: main
README.md... M
airports.txt finalpr...
airports.txt
algorithms.cpp
algorithms.h
algorithms.o U
edge.cpp
edge.h
edge.o U
graph.cpp
graph.h
graph.o U
Talking:
Type 0, 1, 2, 3, or 4 for the following:
0 - BFS
1 - DFS
2 - Dijkstra's Algorithm
3 - Landmark Path
4 - Input New File
Dikjstra
2
Input starting AirportID: 3469
"San Francisco International Airport" | "San Francisco", "United States" | (37.
999, 37.618999)
Input ending AirportID: 3131
"Kempegowda International Airport" | "Bangalore", "India" | (13.197900, 13.1979
Dijkstra's Path: "San Francisco International Airport" -> "Beijing Capital Inte
tional Airport" -> "Kunming Changshui International Airport" -> "Netaji Subhash
andra Bose International Airport" -> "Kempegowda International Airport"

ype 0, 1, 2, 3, or 4 for the following:
- BFS
- DFS
- Dijkstra's Algorithm
- Landmark Path
- Input New File

Talking:

Landmark Path

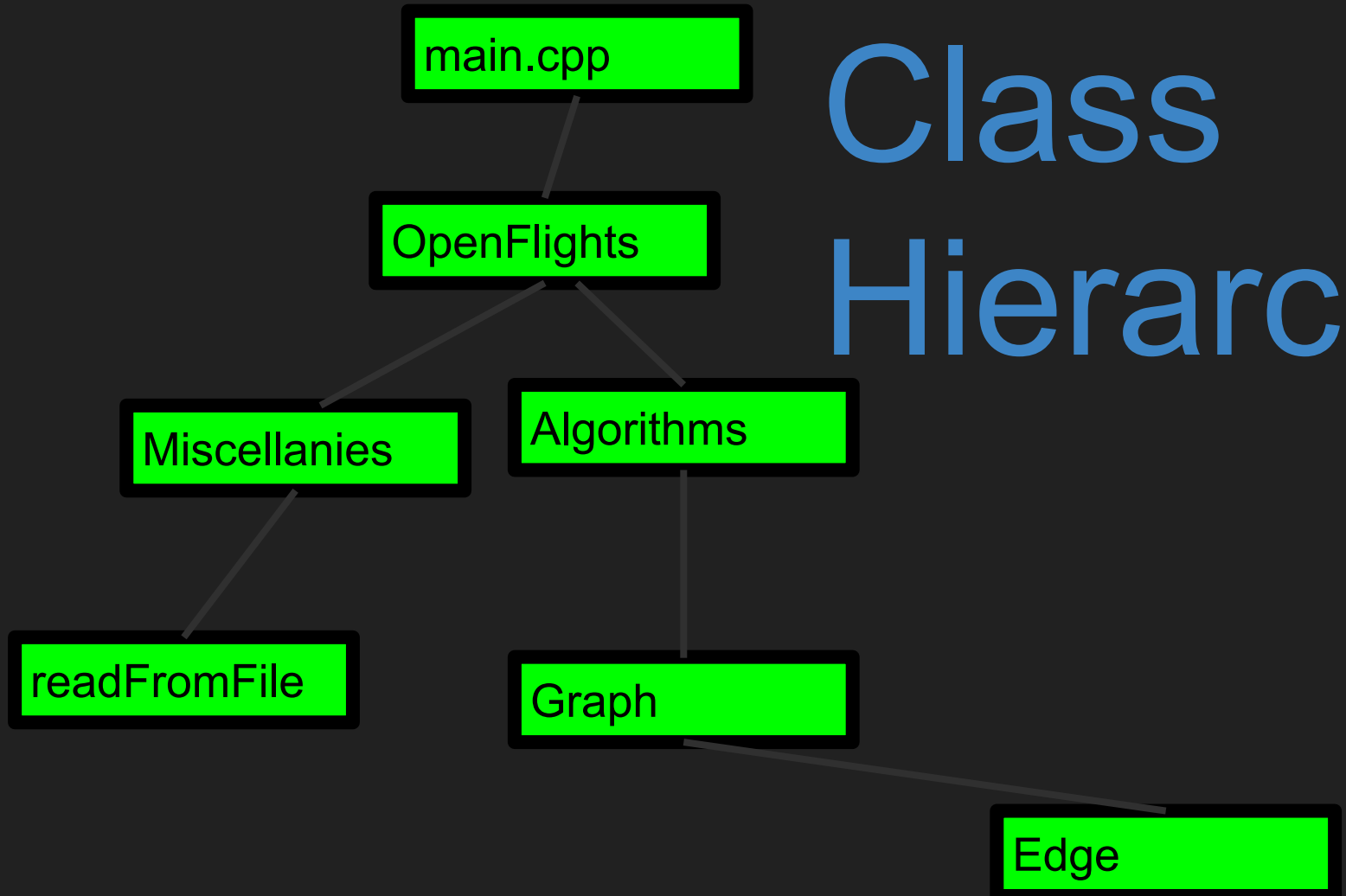
nput starting AirportID: 3469
San Francisco International Airport" | "San Francisco", "United States" | (37.618
99, 37.618999)

nput ending AirportID: 3131
Kempegowda International Airport" | "Bangalore", "India" | (13.197900, 13.197900)

nput checkPoint AirportID: 3316
Singapore Changi Airport" | "Singapore", "Singapore" | (1.350190, 1.350190)

andmark Path: "San Francisco International Airport" -> "Narita International Airp
rt" -> "Singapore Changi Airport" -> "Kempegowda International Airport"

Class Hierarchy



Miscellanies File

Provides basic functions to parse through each line of txt for the files

This function was used to gather the data from the airports.txt and routes.txt files and store it in a manner that could be used for the project.

The functions are grouped based on the files they read the information from

There also exist helper functions to help with getting important numbers such as distance, longitude, latitude, and AirportIDs

OpenFlights File

Goal: To load data from the txt files such as airports.txt and routes.txt

Airports.txt gives the AirportID, airport name, city, country, latitude, and longitude

Routes.txt gives the starting AirportID,

Graphs & Edges Files

Goal: The Graphs file extracts the airport IDs and uses them as vertices as the Edges file extracts the distance through calculating the longitudes and latitudes of starting and ending airports

They help in creating the main graph for use in the Algorithms file

This is a directed edge graph

BFS and DFS

Goals: Traverses and finds easy paths through the use of algorithms such as BFS, DFS, Dijkstra, and Landmark

BFS - Level Order path

DFS - Adjacent path

Dijkstra - Shortest path

Landmark - Shortest path through a checkpoint

Djikstra’s Shortest Path and Landmark Path Algorithm

Goals: Traverses and finds easy paths through the use of algorithms such as BFS, DFS, Dijkstra, and Landmark

BFS - Level Order path

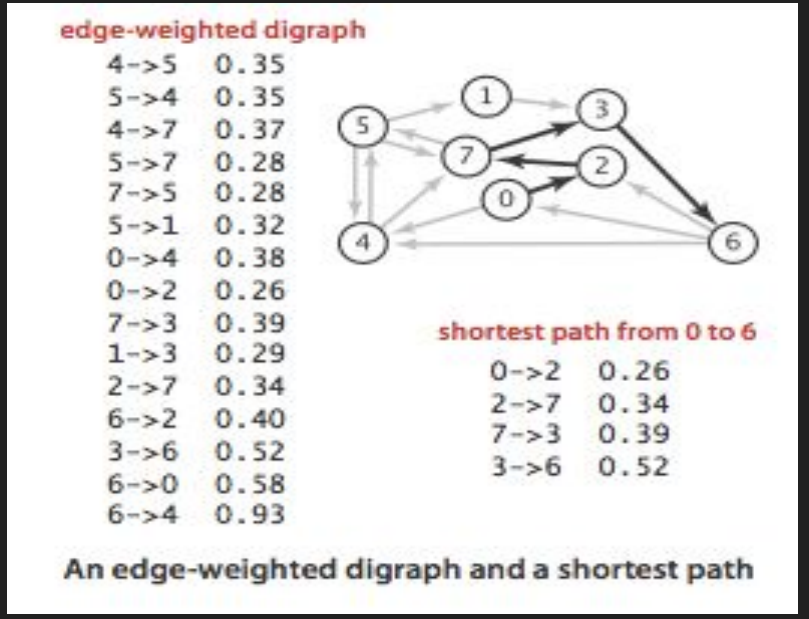
DFS - Adjacent path

Dijkstra - Shortest path

Landmark - Shortest path through a checkpoint

Test Cases

```
#include "catch/catch.hpp"
#include "../graph.h"

TEST_CASE("A simple graph is created p
    std::vector<AirportID> airports;

    for (int i = 1; i <= 10; i++) {
        airports.push_back(i);
    }

    Graph g = Graph(airports);
```




```
[rvasant2@siebl-0224-28 finalproject]$ make test
clang++ tests/catch/catchmain.cpp tests/test_miscellanies.cpp tests/test_graph.cpp
 tests/test_algorithms.cpp OpenFlights.o algorithms.o graph.o edge.o miscellanies.
o readFromFile.o -std=c++1y -stdlib=libc++ -lc++abi -lm -o test
[rvasant2@siebl-0224-28 finalproject]$ ./test
===============================================================================
All tests passed (68 assertions in 9 test cases)
```

Results

We were able to load tens of thousands of datapoints correctly into the graph.

The Algorithms were able to perform their duties without any errors from what we inputted.

We were able to make a UI that is easily able to calculate the algorithms through user inputs such that it was able to easily find the shortest flight paths

```
14110 airports 67663 routes
```

14110 airports.txt data points

67663 routes.txt data points

Working BFS/DFS/Dijkstra’s/Landmark Path

DFS runs on the entire graph and prints in 1 minute 25 seconds. BFS similar.

n Air Force Base" -> "Pensacola Naval Air Station/Forrest Sherman Field" -> "Grand Forks Air Force Base" -> "Buckley Air Force Base" -> "Northwe
ren ""Bud"" Woods Palmer Municipal Airport" -> "Ellington Airport" -> "Whidbey Island Naval Air Station (Ault Field)" -> "Alice International Ai
ir Force Base" -> "Igor I Sikorsky Memorial Airport" -> "Scholes International At Galveston Airport" -> "Dillingham Airfield" -> "Whiteman Air
on Fulton International Airport" -> "Greenwood-Leflore Airport" -> "Francis S Gabreski Airport" -> "Tonopah Test Range Airport" -> "Palm Beach
" -> "North Island Naval Air Station-Halsey Field" -> "Biggs Army Air Field (Fort Bliss)" -> "Bowman Field" -> "Sierra Vista Municipal Libby Ar
erre Haute Regional Airport -> "Grant County International Airport" -> "Edward F Knapp State Airport" -> "San Nicolas Island Nolf Airport" -> "
" -> "Scappoose Industrial Airpark" -> "Menominee Regional Airport" -> "Conroe-North Houston Regional Airport" -> "Patrick Air Force Base" -> "
Base" -> "Mc Alester Regional Airport" -> "Coulter Field" -> "Wright AAF (Fort Stewart)/Midcoast Regional Airport" -> "Esler Regional Airport"
e Base" -> "Minot Air Force Base" -> "Beale Air Force Base" -> "Greater Kankakee Airport" -> "Seymour Johnson Air Force Base" -> "Rancho Muriet
ina Municipal Airport" -> "Polk Army Air Field" -> "Eielson Air Force Base" -> "Angelina County Airport" -> "Ardmore Municipal Airport" -> "Mc
e" -> "Cherry Point MCAS /Cunningham Field/" -> "Emanuel County Airport" -> "Baudette International Airport" -> "Sacramento Executive Airport"
erve Base" -> "Fairchild Air Force Base" -> "Roscommon County - Blodgett Memorial Airport" -> "Tyndall Air Force Base" -> "McChord Air Force Ba
ir Field" -> "Millville Municipal Airport" -> "Castle Airport" -> "Mc Clellan Airfield" -> "Winkler County Airport" -> "Vero Beach Regional Air
Air Force Base" -> "Dyess Air Force Base" -> "Dupage Airport" -> "Hillsboro Municipal Airport" -> "Jacksonville Naval Air Station (Towers Fiel
Air Field" -> "New River MCAS /H/ /Mccutcheon Fld/ Airport" -> "Calexico International Airport" -> "Felts Field" -> "Dade Collier Training and
" -> "Fort Worth Meacham International Airport" -> "Cape Cod Coast Guard Air Station" -> "Boeing Field King County International Airport" -> "W
International Airport" -> "Orcas Island Airport" -> "Friday Harbor Airport" -> "Lackland Air Force Base" -> "Shaw Air Force Base" -> "Majors Ai
A. Young Municipal Airport" -> "Cape May County Airport" -> "Fallon Naval Air Station" -> "Selfridge Air National Guard Base Airport" -> "Naval
st/Boca Chica Field" -> "Northeast Philadelphia Airport" -> "Truth Or Consequences Municipal Airport" -> "Palmdale Regional/USAF Plant 42 Airpo
r Force Base" -> "El Centro NAF Airport (Vraciu Field)" -> "Drake Field" -> "Henry Post Army Air Field (Fort Sill)" -> "Princeton Municipal Air
tterson Air Force Base" -> "Chandler Municipal Airport" -> "Mineral Wells Airport" -> "Mc Connell Air Force Base" -> "New Orleans NAS JRB/Alvin
> "Beaufort County Airport" -> "Phillips Army Air Field" -> "Tucumcari Municipal Airport" -> "Black Rock Airport" -> "Millington-Memphis Airpor
lph Co-Jennings Randolph Field" -> "Hartford Brainard Airport" -> "North Central State Airport" -> "Moffett Federal Airfield" -> "Barking Sands
egard Regional Airport" -> "Bradshaw Army Airfield" -> "Nogales International Airport" -> "Mac Dill Air Force Base" -> "Opa-locka Executive Air
nternational Airport" -> "Muir Army Air Field (Fort Indiantown Gap) Airport" -> "Homestead ARB Airport" -> "Riverside Municipal Airport" -> "Sh
d" -> "Wallops Flight Facility Airport" -> "Holloman Air Force Base" -> "Willow Grove Naval Air Station/Joint Reserve Base" -> "Willow Run Airp
Air Force Base" -> "Lakehurst Maxfield Field Airport" -> "Eareckson Air Station" -> "Nellis Air Force Base" -> "March ARB Airport" -> "Waukega
-> "Griffing Sandusky Airport" -> "Snohomish County (Paine Field) Airport" -> "Mountain Home Air Force Base" -> "Norfolk Naval Station (Chambe
over ARB/Metropolitan Airport" -> "Boca Raton Airport" -> "Quantico MCAF /Turner field" -> "Cannon Air Force Base" -> "Kaneohe Bay MCAS (Marion
port" -> "Offutt Air Force Base" -> "Gulkana Airport" -> "Fort Dodge Regional Airport" -> "Barksdale Air Force Base" -> "Cotulla-La Salle Count
dian Naval Air Station" -> "Hobart Regional Airport" -> "Condron Army Air Field" -> "Unalaska Airport" -> "Atka Airport" -> "Nikolski Air Stati
lane Base" -> "Langley Air Force Base" -> "Columbus Air Force Base" -> "Kendall-Tamiami Executive Airport" -> "Oceana Naval Air Station" -> "Gr
ase" -> "Craig Field" -> "Ladd AAF Airfield" -> "Mc Minnville Municipal Airport" -> "Robins Air Force Base" -> "Andi Jemma Airport" -> "Soroako
iku Airport" -> "Maimun Saleh Airport" -> "Cibeureum Airport" -> "Iswahyudi Airport" -> "Budiarto Airport" -> "Penggung Airport" -> "Tunggul Wu
ondok Cabe Air Base" -> "Dabo Airport" -> "Batu Licin Airport" -> "Frans Sales Lega Airport" -> "Temindung Airport" -> "Tanjung Santan Airport"

Thanks for a great semester!