HIGH POINT UNIVERSITY
Department of Computer Science

CSC4710 Software Engineering

Project Description

This document provides an overview of the Spring 2026 software engineering project. It is not intended to be a comprehensive document – your groups are expected to think about the task and to ask questions to clarify what the client is seeking.

Groups

You will work in groups of about 3 - 5 individuals. Your group pairing will occur randomly. Your group can create its own name etc., and you are to act as a professional entity competing against other teams to win and deliver on a contract.

The project has many parts and many activities ranging from coding, to planning, to documenting. Every team member is expected to contribute to all aspects of the project. In other words, a team member may not avoid coding and just keep meeting minutes, nor may someone just do coding and not maintain some documentation.

Protect your work

Since each group is completing against the others, it is critical that you protect your work product. Hence your directories ought to be closed to others outside your group, files put on GitHub and other third-party sites must be protected so only your group can view them. Failure to do so will result in significant loss of points as I will consider your data stolen and hence your project compromised. In particular, I will consider another organization as having engaged corporate espionage and securing the project based on your work, and that your team failed to win the bid and deliver the product as promised. Espionage may occur from outside your group (external entity stealing your work), or from within (a team member providing access to your work product to an external entity). If the files were deliberately left unsecure, then it may also be considered an honor code violation. You need to protect your intellectual property.

Note the following carefully: "*In the United States and the European Union, it's not legal to copyright any kind of AI-generated content. To address copyright issues, you would need to modify the code generated by ChatGPT in a significant and meaningful way before copyrighting it under the license of your choice. Otherwise, the code is considered to be in the public domain.*"[1] If ChatGPT is used in any way in the project, it is a requirement that the code be modified in a significant and meaningful way.

Organizations must treat data security and copyright seriously.

Note that there is a best project that will be selected. If your files are exposed to others, then you will be disqualified from being eligible for this as it will be deemed that you suffered a data breech and a

[1] https://community.openai.com/t/is-it-permissible-to-use-chatgpt-for-commercial-use/128005

competitor has stolen your intellectual property. The competitor will beat you to the market and present a better prototype to the client who will award the contract to them.

Use tools

You are required to use tools to help you with various aspects of the project. These include the use of GitHub to manage version control, makefiles to manage the compilation and installation of the software for the client, Trello or Monday.com for project and document management (see https://trello.com/guide and https://monday.com/), etc.

The department has a wiki page with some information on Github. It is found at https://pigpen.highpoint.edu/home/csc/tutorial/github.

You may choose any implementation language you believe is appropriate. Be sure to document the discussion, the decision, and the reasons for the decision. The project has 2 parts, different languages can be used in each part, but it is not required that different languages be used.

There is a database component to the project. The client asks that you use dockers for ease of portability, access across multiple members of your team. Helpful information regarding dockers can be found at:

- Docker installation: https://docs.docker.com/get-docker/
- Docker compose (https://docs.docker.com/compose/) is an easy way to setup a docker container using a file. This is the recommended route for deploying your database.
- Installing MariaDB, the preferred database of the client, on the docker requires a MariaDB docker image. That image is found at https://hub.docker.com/_/mariadb.
- An example of how to keep the data persistent in eth database once it has been created (i.e., maintain the data from one execution to another) is found at https://www.beekeeperstudio.io/blog/how-to-use-mariadb-with-docker.

Journal

Everybody must purchase a bound journal – lose leaf binders etc. will not be acceptable. The journal is to be used to document your design, your meetings, your thoughts, the various design considerations you considered and why you selected the one you did etc. In short, everything to do with the project finds its way into the journal. It is your record of what you contributed to the project. All entries must be dated, pages may not be torn out of the journal, and it must be kept up to date. You may be asked to produce your journal at any time.

In the real world, such a journal could be used to prove you were not negligent in the case of a financial loss or personal injury resulting from your software. In a lawsuit, you would have to show you considered various options, why you chose the pathway you did, and how you adhered to professional standards. If you were found to be negligent, you could lose all your assets, or face jail time. In the project, the journal will document what you considered, what you did, the reasons behind it, the discussions you had (and with whom), the testing undertaken, etc. All entries must be dated and completed in a timely manner.

Project

Background

Your client is a small group of wealthy investors who have decided to start their own airline. The airline is named Panther Cloud Air. They are currently exploring the feasibility of their business plan and want to develop a simulation to see how robust it is, and to learn more about the logistics involved in running an airline. Their goal is to make a profit, and to provide excellent service at a reasonable price. They believe that this will provide them with a competitive advantage over the existing, large airlines.

Panther Cloud Air has contacted multiple organizations (the groups) and asked them to demonstrate their capabilities by developing a prototype system to address their needs. The best prototype demonstrated at the end of the semester will win the contract. At the end of the semester, each group will give a 20-minute presentation and a demonstration of their system (every group member will participate in the presentation and demonstration). The class will be asked to determine the best prototype (you cannot vote for your own). The group determined to be the best will be awarded with the best project of the class.

The FAA has granted Panther Cloud Air authority to fly in/out of the top 30 US airports as defined by the webpage https://en.wikipedia.org/wiki/List_of_the_busiest_airports_in_the_United_States. The GPS coordinates of each US airport can be found by following the link for each airport on the webpage. In addition, a daily flight from New York to Paris is planned. Some airport details are found at: https://en.wikipedia.org/wiki/Charles_de_Gaulle_Airport. The airport will be serviced by one flight per day from New York to Paris, and one from Paris to New York. These wishing to travel to Paris from cities other than New York, will need to make a connection in New York. WE would like to minimize the number of people who are forced to have an overnight stay in New York in order to travel to Paris.

Take-off and landing fees are Euro 2100. The cost of aviation fuel in Paris is Euro 1.97/liter. The cost of fuel and take-off and landing fees are billed to the airline at the end of each month.

The exchange rate at the end of each month is derived from xe.com (Use the exchange rate that existed on 01/31/26 as the exchange rate for 01/31/26 etc),

Timetables should be produced in English. For each route, provide the origin airport, destination airport indicating arrival and landing times. List all stopovers and the amount of time on the ground during each stop-over. Also list the total time and total distance travelled.

Pay attention to metric versus imperial units of measurement, and the way city names are spelled in each language. The timetable must present the information in a culturally correct manner.

Also pay attention to daylight savings. Not all states observe daylight savings, and France and the US do not necessarily start and end daylight savings on the same dates.

You can calculate the distance between any two GPS coordinates using the Great Circle calculation as discussed at https://www.omnicalculator.com/math/great-circle. The investors are only willing to consider flights between airports that are more than 150 miles apart. Note: pay attention to the units of measurement. The data is not always provided in consistent units, so conversions may be necessary. Panther Cloud Air has secured a few gates at each airport. The number of gates rented is related to the metro population serviced by the airport. Panther Cloud Air has access to one gate for every million people in the metro area, with a maximum of 5 gates at any airport, except for an airport that is designated a hub (used heavily for passengers by passengers travelling from A to B with one of more transit stops). Hubs have 11 gates available to Panther Cloud Air. If a flight lands at an airport and a gate is not available, then the aircraft must wait on the tarmac. The flight time for any flight is measured as the time from when the aircraft leaves the gate at the source airport, to the time it arrives at a gate at the destination airport. Passengers may only board and disembark the aircraft when it is at a gate. It takes a minimum of 40 minutes to turn around an aircraft at a gate (time to disembark passengers [15 mins], clean the aircraft and change crew [10 mins], and board passengers [15 mins]). If the aircraft needs refueling, then an additional 10 minutes is needed – total of 50 minutes.

Passengers who are in transit at an airport require at least 30 minutes to disembark, walk to the gate, and board another flight. The aircraft door must be closed 15 minutes before departure to allow the crew to go through the safety video, ensure all luggage is stowed, and all passengers a reseated and wearing seat belts.

The investors have leased terminal space at each US airport and are charged $2,000 per take-off and landing at each location. This covers the lease expenses for baggage handling equipment, counter space, gates, and a carbon offset fee.

The webpage, https://www.boeing.com/commercial/airports/plan_manuals.page provides aircraft characteristics. The investors have leased 15 Boeing 737-600 aircraft, 15 Boeing 737-800 aircraft, 12 Airbus A200-100 aircraft, and 13 Airbus A220-300 aircraft. Various websites such as the following provide useful technical data:

- https://www.boeing.com/commercial/airports/plan_manuals.page,
- https://boeingcorporation.webnode.page/boeing-737-600/
- https://boeingcorporation.webnode.page/boeing-737-800/
- http://www.b737.org.uk/techspecsdetailed.htm
- https://www.modernairliners.com/airbus-a220#specs

The monthly leasing costs of each aircraft is given below:

Boeing 737-600	US$245,000/month
Boeing 737-800	US$270,000/month
Airbus A200-100	US$192,000/month
Airbus A220-300	US$228,000/month

Leasing fees include maintenance. Maintenance can only occur at airports designated as hubs, and each aircraft requires maintenance after 200 hours of flight. Maintenance takes 1.5 days. Each hub can service no more than 3 aircraft for maintenance at any one time.

Panther Cloud Air have secured a long-term (1-year) fixed price for aviation fuel at US$6.19/gallon.

Panther Cloud Air will fly aircraft at 80% of the maximum airspeed that they are capable of. This provides better fuel economy, and some power in reserve should it be necessary in an emergency. Note that an airspeed of 700 km/hr with a tail wind of 100 km/hr results in a ground speed of 800 km/hr. The impact of the prevailing wind (West to East) and the rotation of the earth means that flights travelling due West take 4.5% longer than anticipated based on the distance and airspeed. Flights travelling due East take 4.5% less time than anticipated based on distance and airspeed. The impact of the prevailing wind and earth's rotation for flights that are not due East or due West is to be calculated based on the heading of the flight. The flight heading can be calculated based on the GPS coordinates of the airports by using the formula discussed at: https://www.igismap.com/formula-to-find-bearing-or-heading-angle-between-two-points-latitude-longitude/. Hence if an aircraft's maximum airspeed is 500km/hr and it operates at 80%, then the intended airspeed is 400km/hr. If the aircraft must travel a total distance of 1,350 km, then this should be a flight time of 3 hours, 22 minutes. However, if the direction of travel is due East, then the flight time will be 4.5% less (i.e., 3 hours and 13 minutes). If the direction of travel is due West, then the flight time would be 3 hours and 32 minutes. If the heading was due North or due South, then the flight time would be 3 hours and

22 minutes. If the heading were 60° (due North is 0°, due West is 90°), then the flight time would need to be calculated.

Panther Cloud Air has a business plan to offer flights between each of the cities in the top 30 airports with the exception of airports that are less than 150 miles apart. Note that there is no need for direct flights from each airport to every other. Panther Cloud Air plans to utilize 3-4 hubs which will serve as transit points for many flights (but not all). Your team is being asked to determine the most convenient/useful hubs. That is to say, identify the hubs that will maximize the airlines profit and convenience for the passengers.

Ideally flights will be at least 75% full, but airfares will be charged on the assumption that the aircraft is 30% full and needs to cover the expenses identified above. This is to ensure that the airline turns a profit and can expand operations in the future. On an average day, 0.5% of the population travels by air. Panther Cloud Air expects to take 2% of the market share initially, growing to a 5% market share by year's end (which may permit the leasing of additional aircraft), and then to a more significant share over the coming 2 years. The arrival rate of passengers at each airport is assumed to be constant throughout the day during the available hours to fly from a source airport to a destination airport. The passengers passing through an airport on any given day is in proportion to the population of the metro area served by the airport. Airports operate from 5:00am until 1:00am for domestic flights,

To determine demand for travel from any airport (source) to any other reachable airport (destination), the assumption is that is proportional to the size of the metro population of the destination airport relative to the total metro populations of all reachable airports. That is to say that if we consider airport A as the source airport, and airport B (A ≠ B) has a metro population of 10M people and the total population of all reachable airports is 175M people (excludes metro population of the airport A), then 10/175 =5.71% of all passengers departing the airport A want to travel to airport B. Since airports operate 20 hours per day and you cannot schedule a landing after the destination airport's closing time, then the number of hours available for travel between A and B may be less than 20 hours. Hence, if airport A has a metro population of 1M people, then if 0.5% of the population wishes to fly on any given day, and Panther Cloud Air holding 2% market share, and 5.71% of passengers wishing to travel to airport B, then a total of 6 passengers wish to travel from A to B on any given day. Their preferred travel times are equally distributed across the available time each day.

Client's environment

The client will run your software on a Dell Pro 14 Premium PA14250 with 32 GB of RAM. The OS used is Microsoft Windows 11 Enterprise. The machine utilizes the Intel Core Ultra 7 268V, 2200 Mhz, 8 Core processor and has a 14-inch monitor. 120Gb of disk space is available. The client will execute the software from a terminal window which effectively is a Linux environment very similar to cs.highpoint.edu. However, it is a standard distribution of Linux and hence to ensure portability, you must ensure documentation is provided on how to install any packages that you use, how to access databases, etc. The client machine potentially uses a different default version of the compiler that may be available on cs.highpoint.edu, so be sure the calls to the compiler in the makefile has the necessary flags to ensure the expected version is executed (e.g., 2020 version of the gcc compiler, as opposed to the 2023 version).

Project part 1

Given the information above, create a timetable. You may start with each aircraft at an airport of your choosing. Create a schedule so that passengers can get from one airport to any other (subject to any constraints identified above). You may assign any flight number you wish to a flight (e.g., CA1234), but only one flight with that number may be in the air at any one time. You may assign a unique designator/tail number) to each aircraft (e.g., see https://blueskypit.com/2022/11/license-plates-for-planes-how-to-understand-tail-numbers/#:~:text=Aircraft%20registration%20numbers%2C%20or%20tail,license%20plate%20on%20a%20car.) Flights may be non-stop, or may have multiple stops, between the source and destination airports. The timetable should be maintained in a database and clearly show the arrival and departure times of each flight, the airports involved, and the passenger capacity on that flight. This database will be used in the second part of the project.

The schedule for a flight records the departure time as the time the aircraft pushes back from the gate and the arrival time as the time it reaches the gate. What is missing is the time taken to reach the runway (taxi time), time to takeoff/land, time to accelerate to cruising altitude etc. In addition, we overestimated each aircrafts maximum speed. These details are below and should be incorporated into your timetable and a simulation of events.

Airports have different size and number of runways etc. Smaller airports with less traffic allow for faster access to the runway from the terminal than larger airports.

For an airport that is not a hub, we will use the following estimate for the time to taxi to/from the runway/terminal:

- min of (13 minutes, (population of metro area * 0.00075%) minutes).

That is to say, the taxi time (in minutes) is a function of the size of the metro areas being serviced by the airport, with a maximum taxi time of 13 minutes.

For an airport that is a hub we will use the following approximation for the taxi time to/from the runway/terminal:

- 15 minutes for a metro area <= 9M people.
- Each additional 2M people in the metro area adds another 1 minute to the taxi time.
- The maximum taxi time is 20 minutes

Each aircraft spends 1 minute on the runway in order to take-off. During this time, it accelerates from 0 to 150 knots (note the different unit of measurement).

On landing, the aircraft spends 2 minutes on the runway and during that time it decelerates from 200 knots to 0.

Each aircraft ascends at an angle of 6 degrees. It will travel at 250 knots until it reaches an altitude of 10,000 feet, it then accelerates to 280 knots until it reaches its cruising altitude. Once cruising altitude is reached, the aircraft accelerates to a speed not to exceed 80% of the maximum possible speed for the aircraft. This acceleration happens at a uniform rate of 25 knots/minute.

On descent, each aircraft will descend at a rate of 1,000 feet for every 3 nautical miles travelled (again, note the unit of measurement). The descent will be at 250 knots until an altitude of 10,000 feet is reached, Below 10,000 feet, the aircraft will travel at 200 knots until landing. Aircraft will decelerate at a constant rate of 35 knots/minute.

We will ignore the elevation of the airport for the sake of simplicity.

For international flights, the cruising altitude is 38,000 feet.
For flights more than or equal to 1,500 miles, the cruising altitude is 35,000 feet.
For flights less than 1,500 miles, the cruising altitude is 30,000 feet.
For flights less than 350 miles, the cruising altitude is 25,000 feet
For flights less than 200 miles, the cruising altitude is 20,000 feet.

Be sure that each aircraft starts its day in at the airport it ended the previous day at. Aircraft cannot magically teleport to another airport overnight.

A printed version of the timetable should also be available in English. An interface English for a passenger to look for a flight from airport A to airport B must also be provided. If it is possible to get from A to B then the flight options for that day should be shown, which includes the departure/arrival times, the airports involved (including the length of any layover), and the cost of the trip.

Project part 2
Using the timetable from part 1 above, simulate two weeks' worth of flight activity. Collect all data in a database which can be queried later. Record the following data (minimally):

For every flight: Flight number, data of flight, departure airport, destination airport, number of passengers, scheduled, departure time, actual departure time, scheduled arrival time, actual arrival time, aircraft tail number.

For every passenger: Source airport, destination airport, flights taken (flight number, source airport, destination airport, scheduled departure time, actual departure time, scheduled arrival time, actual arrival time).

For each airport: Arrival time of each aircraft, flight number as arriving aircraft, number of arriving passengers, departure time of each aircraft, flight number as departing aircraft, number of departing passengers, gate used, aircraft tail number.

For each aircraft: Aircraft tail number, for each flight: date of flight, flight number, departure airport, destination airport, departure time, arrival time, number of passengers.

It is up to you how you organize your database tables. See the notes on dockers and MariaDB above.

The simulation should encounter deal with the following circumstances.

Day	*Challenge*
1	Follow the timetable generated from part 1 of the project.
2	No delays. Aircraft are to start the day at the airport they ended at on the previous day.
3	25% of all flights encounter bad weather and the flight time is extended for a random amount of time between 1 minute and 15% of the flight time.
4	No delays. Aircraft are to start the day at the airport they ended at on the previous day.
5	20% of all flights originating above 40° N are delayed on the ground (not at the gate) due to icing for a random amount of time between 10 minutes and 45 minutes.
6	No delays. Aircraft are to start the day at the airport they ended at on the previous day.
7	There is a strong jet stream and flights travelling due East have flight times extended by 12%, flights travelling due West have flights shortened by 12%. All other flights have flight times impacted accordingly based on the initial heading of the flight.
8	No delays. Aircraft are to start the day at the airport they ended at on the previous day.
9	5% of flights are delayed at the gate by a random amount of time ranging from 5 minutes to 90 minutes.
10	No delays. Aircraft are to start the day at the airport they ended at on the previous day.

11	You suffer an aircraft failure at one of the major Comfort Airline hubs. The aircraft is taken out of commission for the entire day. The aircraft is towed away from the gate for unscheduled maintenance.
12	No delays. Aircraft are to start the day at the airport they ended at on the previous day.
13	8% of all flights originating west of 103° W are cancelled. Passengers must be put of other flights in order to reach their destination.
14	No delays. Aircraft are to start the day at the airport they ended at on the previous day.

After the completion of the simulation, a mechanism providing the ability to query the database of collected data is also necessary. For example, it should be possible to follow a particular tail number and find out which airports the plane landed at/departed from, number of passengers carried, percentage of time the aircraft had an on-time departure and arrival, and hours operated.

At the end of the simulation, there should be a report generated that provides the following details:

1. Number of passengers transported.
2. Operating cost.
3. Revenue raised.
4. Profit/loss.