Lillian Joelson and Karen Lin
SI 201 - Data-Oriented Programming
Barbara Jane Ericson
15 Dec 2025
GitHub Link: https://github.com/lkarenin/SI_201-Final-Project

Final Project Report

1. **Project Goals**
    Planned APIs
    i. OpenWeather: A weather API that allows us to access the weather conditions of any location we desired; we specifically accessed reports for Detroit, Michigan
        1. **Historica**l weather data
            a. Airport location (city)
            b. Date/time
            c. Temperature
            d. Humidity
            e. Wind speed
            f. Weather description (sunny, rainy, cloudy, snow, etc.)
    ii. AviationStack: A flight API that would give us the schedule of flights and their actual departure times in Detroit
        1. **Historical** flight data
            a. Flight number
            b. Airline
            c. Departure airport (IATA code)
            d. Arrival airport (IATA code)
            e. Scheduled departure & arrival time
            f. Actual departure & arrival time
            g. Delay (minutes)
    Our goal: Discover the average amount of delay time for flights departing from Detroit, Michigan during weather with precipitation
2. **Achieved Goals**
    Actual APIs - we used the same ones as planned however the data changed slightly
    i. AviationStack: A flight API that would give us the schedule of flights and their actual departure times in Detroit
        1. **Real-time** flight data - we couldn't access historical flight data for free, so we changed the data to collect real time departure flights from the airport instead

a. Flight number
b. Airline
c. Departure airport (IATA code)
d. Arrival airport (IATA code)
e. Scheduled departure & arrival time
f. Actual departure & arrival time
g. Delay (minutes)

ii. OpenWeather: A weather API that allows us to access the weather conditions of any location we desired; we specifically accessed reports for Detroit, Michigan

1. **Real-time** weather data - because of the constraint with the AviationStack API, we also transitioned our weather data to be collected in real-time so that it would be compatible with our flight data
    a. Airport location (city)
    b. Date/time
    c. Temperature
    d. Humidity
    e. Wind speed
    f. Weather description (sunny, rainy, cloudy, snow, etc.)

3. Problems

API Constraints

i. Because we could only gather real time information instead of historical information, we couldn't organize our information by month in the way that we planned. We changed our plan from gathering monthly data to gathering data by the hour over the course of one day. This way, we could still calculate the average while allotting for the time constraints.

Collaboration cross VS Code and GitHub

ii. On project 1 we had tried to work on one VS Code file simultaneously, but because Karen was the owner, Lilly couldn't access the file unless Karen had it open on her computer, making asynchronous collaboration difficult. For this project we took a different approach. Karen was responsible for working with the weather API and Lilly was responsible for working with the flight API. We each created our own GitHub repositories and our own VS Code files that we could work with our individual portion of the data on. We then shared the GitHub repositories with each other, and as we make updates and commits to our own repositories, we would text the other person about our updates. Then that person could

create a file for the code the other team member wrote and copy + paste their work into their own VS Code file. This way we could work asynchronously while still having access to the other person's code.

4. **The calculations from the data in the database**

delay_calculations.txt

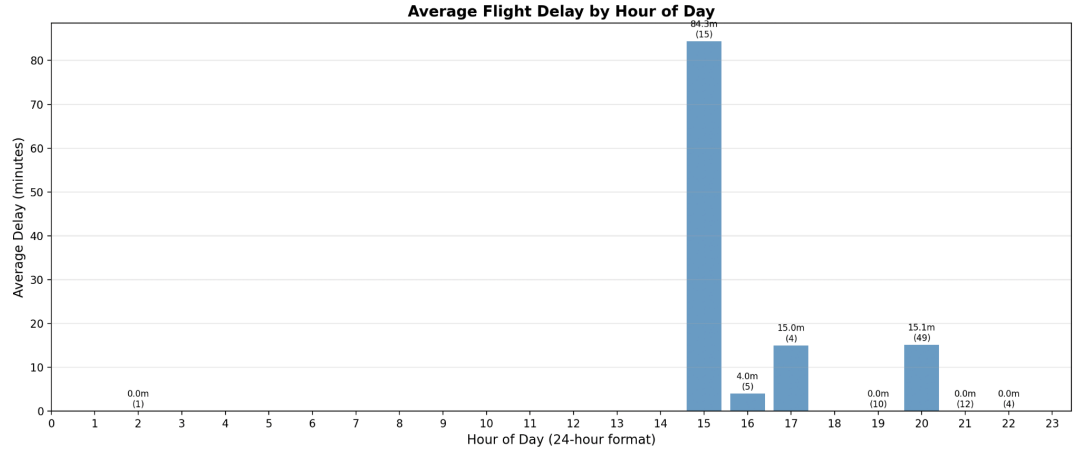
```
FLIGHT DELAY DURING PRECIPITATION
Total flights: 100
Flights with delay data: 100
Total weather records: 100
Flight dates range: 2025-12-13T17:55:00+00:00 to 2025-12-15T02:00:00+00:00
Weather fetch dates range: 2025-12-13T15:21:56.894660 to 2025-12-14T20:15:20.591934
Weather records with precipitation: 14

Total flight-weather matches within 3 hours: 266
RESULTS
Flights during precipitation: 114
Total flight-weather matches: 266
Average departure delay during precipitation: 13.00 minutes

```

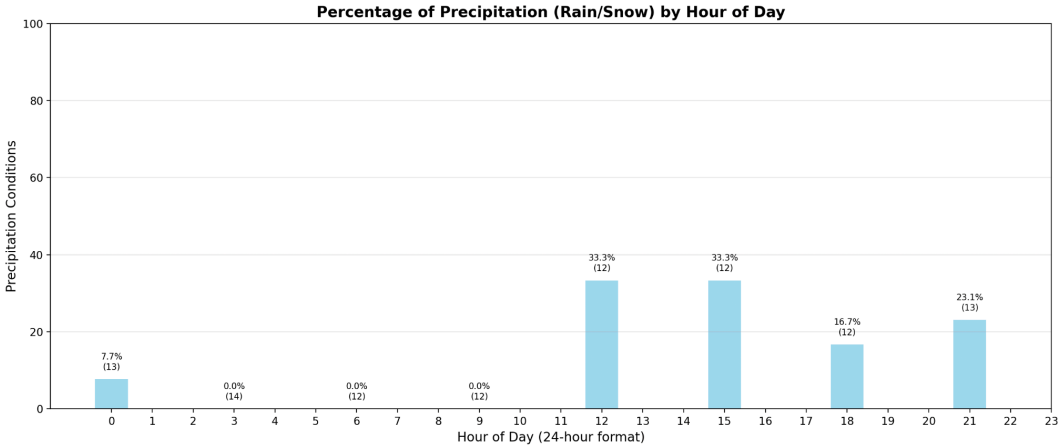
```python
def calc_avg_delay_precip(db_conn, output_file="delay_calculations.txt"):
    cur = db_conn.cursor()

    with open(output_file, 'w') as f:
        f.write("FLIGHT DELAY DURING PRECIPITATION\n")

        # flight ct
        cur.execute("SELECT COUNT(*) FROM Flights")
        flight_count = cur.fetchone()[0]
        line = f"Total flights: {flight_count}\n"
        print(line.strip())
        f.write(line)

        # FlightDelays
        cur.execute("SELECT COUNT(*) FROM FlightDelays WHERE delay_minutes IS NOT NULL")
        delay_count = cur.fetchone()[0]
        line = f"Flights with delay data: {delay_count}\n"
        print(line.strip())
        f.write(line)

        # weather
        cur.execute("SELECT COUNT(*) FROM WeatherData")
        weather_count = cur.fetchone()[0]
        line = f"Total weather records: {weather_count}\n"
        print(line.strip())
        f.write(line)

        # date ranges; need to join w Timestamps table
        cur.execute("""
            SELECT MIN(T.timestamp), MAX(T.timestamp)
            FROM Flights F
            JOIN Timestamps T ON F.scheduled_departure_id = T.id
            WHERE T.timestamp IS NOT NULL
        """)
        flight_dates = cur.fetchone()
        line = f"Flight dates range: {flight_dates[0]} to {flight_dates[1]}\n"
        print(line.strip())
        f.write(line)

        cur.execute("""
            SELECT MIN(FT.timestamp), MAX(FT.timestamp)
            FROM WeatherData W
            JOIN FetchTimestamps FT ON W.fetch_timestamp_id = FT.id
        """)
        weather_dates = cur.fetchone()
        line = f"Weather fetch dates range: {weather_dates[0]} to {weather_dates[1]}\n"
        print(line.strip())
        f.write(line)
```

```python
# check for preci in weather data
precip = ['rain', 'snow', 'drizzle', 'sleet', 'hail']
precip_condition = " OR ".join([f"LOWER(WD.description) LIKE '%{term}%'" for term in precip])

cur.execute(f"""
    SELECT COUNT(*)
    FROM WeatherData W
    JOIN WeatherDescriptions WD ON W.description_id = WD.id
    WHERE {precip_condition}
""")
precip_count = cur.fetchone()[0]
line = f"Weather records with precipitation: {precip_count}\n\n"
print(line.strip())
f.write(line)

# join flights w weather n match flights to weather forecasts w/in 3 hours of scheduled departure
flight_weather_sql = """
    SELECT
        fd.delay_minutes,
        WD.description,
        T.timestamp as flight_time,
        W.datetime as weather_time
    FROM Flights F
    JOIN FlightDelays fd ON F.flight_id = fd.flight_id
    JOIN Timestamps T ON F.scheduled_departure_id = T.id
    CROSS JOIN WeatherData W
    JOIN WeatherDescriptions WD ON W.description_id = WD.id
    WHERE fd.delay_minutes IS NOT NULL
    AND T.timestamp IS NOT NULL
    AND ABS(
        (strftime('%s', T.timestamp) - W.datetime)
    ) <= 10800
"""

cur.execute(flight_weather_sql)
rows = cur.fetchall()

line = f"Total flight-weather matches within 3 hours: {len(rows)}\n"
print(line.strip())
f.write(line)

if len(rows) == 0:
    error_msg = "Error: No temporal overlap between flights and weather data. Your flight timestamps a
    print(error_msg.strip())
    f.write(error_msg)
    return None
```

```python
# cal avg delay during preci weather
    delays = []
    for delay, desc, flight_time, weather_time in rows:
        desc_lower = desc.lower()
        if any(term in desc_lower for term in precip):
            delays.append(delay)

    if len(delays) == 0:
        error_msg = f"\nNo flights found during precipitation weather.\n(Out of {len(rows)} flight-weather matches)\n"
        print(error_msg.strip())
        f.write(error_msg)
        return None
    else:
        avg_delay = sum(delays) / len(delays)
        f.write("RESULTS\n")

        line = f"Flights during precipitation: {len(delays)}\n"
        print(line.strip())
        f.write(line)

        line = f"Total flight-weather matches: {len(rows)}\n"
        print(line.strip())
        f.write(line)

        line = f"Average departure delay during precipitation: {avg_delay:.2f} minutes\n"
        print(line.strip())
        f.write(line)

        return avg_delay
```

5. Visualizations

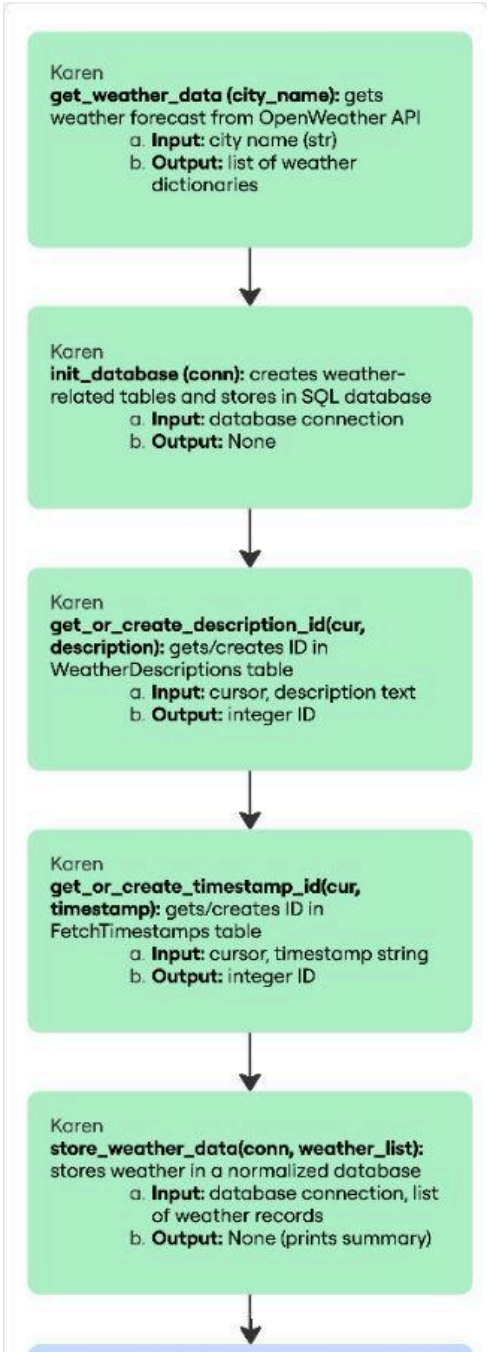


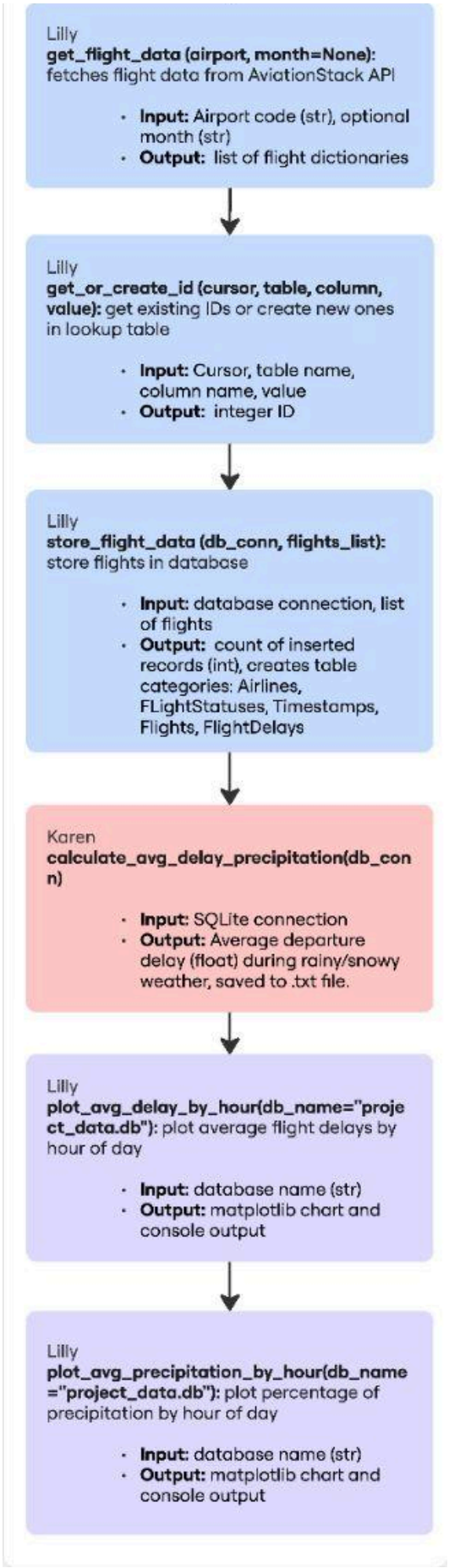


6. Instructions

AviationStack API key: 52866fb0c723c8b58cd3b8f8eaa6f169
OpenWeather API key: 2aee95c86e2cf484f13b865933689b2a
Run **flights_api.py** to access flight information in Detroit via the AviationStack API and then **weather_api.py** to access weather information in Detroit via the OpenWeatherMap API. Since ea age amount of time in delays for flights departing in Detroit during weather with precipitatory conditions in **delay_calculations.txt**.

7. Function diagram


Karen
get_weather_data (city_name): gets weather forecast from OpenWeather API
a. **Input:** city name (str)
b. **Output:** list of weather dictionaries
Karen
init_database (conn): creates weather-related tables and stores in SQL database
a. **Input:** database connection
b. **Output:** None
Karen
get_or_create_description_id(cur, description): gets/creates ID in WeatherDescriptions table
a. **Input:** cursor, description text
b. **Output:** integer ID
Karen
get_or_create_timestamp_id(cur, timestamp): gets/creates ID in FetchTimestamps table
a. **Input:** cursor, timestamp string
b. **Output:** integer ID
Karen
store_weather_data(conn, weather_list): stores weather in a normalized database
a. **Input:** database connection, list of weather records
b. **Output:** None (prints summary)


Lilly
get_flight_data (airport, month=None): fetches flight data from AviationStack API
• **Input:** Airport code (str), optional month (str)
• **Output:** list of flight dictionaries
Lilly
get_or_create_id (cursor, table, column, value): get existing IDs or create new ones in lookup table
• **Input:** Cursor, table name, column name, value
• **Output:** integer ID
Lilly
store_flight_data (db_conn, flights_list): store flights in database
• **Input:** database connection, list of flights
• **Output:** count of inserted records (int), creates table categories: Airlines, FLightStatuses, Timestamps, Flights, FlightDelays
Karen
calculate_avg_delay_precipitation(db_conn)
• **Input:** SQLite connection
• **Output:** Average departure delay (float) during rainy/snowy weather, saved to .txt file.
Lilly
plot_avg_delay_by_hour(db_name="project_data.db"): plot average flight delays by hour of day
• **Input:** database name (str)
• **Output:** matplotlib chart and console output
Lilly
plot_avg_precipitation_by_hour(db_name="project_data.db"): plot percentage of precipitation by hour of day
• **Input:** database name (str)
• **Output:** matplotlib chart and console output

8. Resource documentation

Date	Issue Description	Location of Resource	Result Did it solve the issue?
12/10/2025	Formatting and debugging flights_api	Claude AI	Lilly Yes, I was having some issues that I couldn't work out with the formatting of the function and Claude helped me debug and gave advice on how to restructure it
12/10/2025	Assistance with SQLite tables	Claude AI	Karen Yes, I requested guidance on structuring my SQLite database tables to properly store flight and weather data from the OpenWeather API
12/11/2025	Got advice on how to change formatting to adjust for data only being collected in real time instead of historically	Claude AI	Lilly and Karen Yes, it advised us to calculate by hour instead of by month and helped adjust our code to accommodate this
12/12/2025	Debugging SQLite errors	Claude AI	Karen Yes, I ran into a couple SQLite-related errors throughout my project so I had Claude help with debugging based on outputted error messages
12/13/2025	Making integer keys for repeating strings in flights_api	Claude AI	Lilly Yes, Claude helped guide me through how to create integer keys for flights_api because it had a lot of repeating strings
12/13/2025	Making integer keys to prevent duplicate string data in the database	ClaudeAI	Karen Yes, I asked Claude for help in creating integer keys to prevent duplicate string data after we received feedback from our grading session
12/15/2025	Adjusting visualizations for	Claude AI	Lilly Yes, Karen had to change some

	changes made in the weather_api file		formatting in her weather_api file, so the visualizations file needed to be adjusted for that, Claude gave me advice on how to do that because I wasn't familiar with the changes Karen made in her code