DataEng S24: Project Assignment 3

Data Integration

Due date: May 26, 2024 at 10pm

Congratulations! By now you have a working, end-to-end data pipeline. Unfortunately, it does not have enough data to properly implement our Data Scientist's visualization. To fill out information such as "route ID" you need to access another source of data and build a new pipeline to integrate it with your initial pipeline. Here are your steps:

A. access the stop event data
B. build a new pipeline for the stop event data
C. integrate the stop event data with the breadcrumb data
D. testing

A. Stop Events Data

Access TriMet "Stop Events" data at this URL:

```
https://busdata.cs.pdx.edu/api/getStopEvents?vehicle_num=<vehicle_num>
```

As with the previous data source, this data set gives all TriMet vehicle stop events for a single day of operation. Again, make sure to replace the vehicle_num with the vehicle id's assigned to you.

B. New Pipeline

Your job is to build a new pipeline that operates just like the previous one, including use of Cloud Pub/Sub, automation, validation and loading.

C. Integrate Stop Events with Bread Crumbs

The two pipelines (BreadCrumb pipeline and StopEvent pipeline) must update the values in the Trip table such that all of the columns of both tables are filled correctly.

Alternatively, it would be OK to load the StopEvent data into a separate table and then use SQL views to integrate the two datasets.

D. Visualization

MapboxGL is a data visualization tool that allows you to view your breadcrumb data and display it on a map. Your job is to integrate this tool with your database tables so that you can query the breadcrumb and trip data in your database server, transform to geoJSON format and display the resulting map visualization. To get started, see this guide.

Alternatively, you may use an alternative visualization tool (such as folium) to create the required visualizations. We do not provide any guides for doing it, but you are free to do so if you prefer. The submitted visualizations must be equivalent or superior to the visualizations produced by the provided MapboxGL based visualization tool.

Submission

Make a copy of this document and update it to include the following visualizations. For each visualization extract from your database a list of (latitude, longitude, speed) tuples and then use the provided visualization code (see Section D above) to display bus speeds at all of the corresponding geographic coordinates. So, for example, if you are asked to visualize a “trip”, then you must query your database to find all of the (latitude, longitude, speed) tuples for that trip, and then display a map showing the recorded/calculated bus speed at each (latitude,longitude) location.

No need to produce software that neatly displays trips, routes, dates, times, etc. onto the visualization itself. Instead, just paste a screen capture of the map-based speed visualization into your submission document and then include a text description of the contents of the visualization. For example, text like this: “Bus Speeds for all outbound trips of route 72 between 9am and 11am on Wednesday, February 15, 2023.”

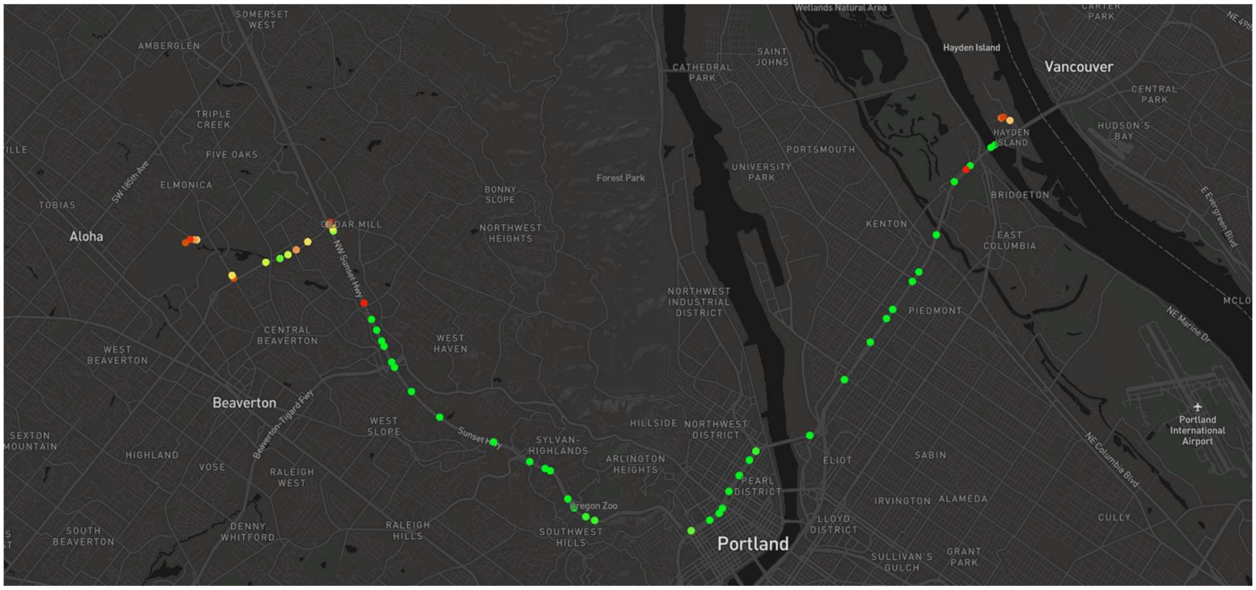
Visualization 1. A visualization of speeds for a single trip for any bus route that crosses the US-26 tunnel. You choose the day, time and route for your selected trip. To find a trip that traverses this tunnel, consider finding a trip that includes breadcrumb sensor points within this bounding box: [(45.506022, -122.711662), (45.516636, -122.700316)]. Any bus trip that includes breadcrumb points within that box either drove across the tunnel or teleported across!

```
with cte as (SELECT trip_id FROM breadcrumb WHERE latitude BETWEEN 45.506022 AND
45.516636 AND longitude BETWEEN -122.711662 AND -122.700316 AND DATE(tstamp) =
'2023-01-16' GROUP BY trip_id ORDER BY COUNT(trip_id) DESC LIMIT 1)
SELECT longitude, latitude, speed FROM breadcrumb WHERE trip_id = (select trip_id from
cte) ORDER BY tstamp;
```

```
PGPASSWORD='Project@123' psql -h localhost -p 5432 -d postgres -U postgres -c "with
cte as (SELECT trip_id FROM breadcrumb WHERE latitude BETWEEN 45.506022 AND
45.516636 AND longitude BETWEEN -122.711662 AND -122.700316 AND DATE(tstamp) =
'2023-01-16' GROUP BY trip_id ORDER BY COUNT(trip_id) DESC LIMIT 1)
```

```
SELECT longitude, latitude, speed FROM breadcrumb WHERE trip_id = (select trip_id from
cte) ORDER BY tstamp;" -o output1.tsv -F '\t' -A
```

The below visualization shows the bus that crosses the US-26 tunnel on January 16th, 2023.

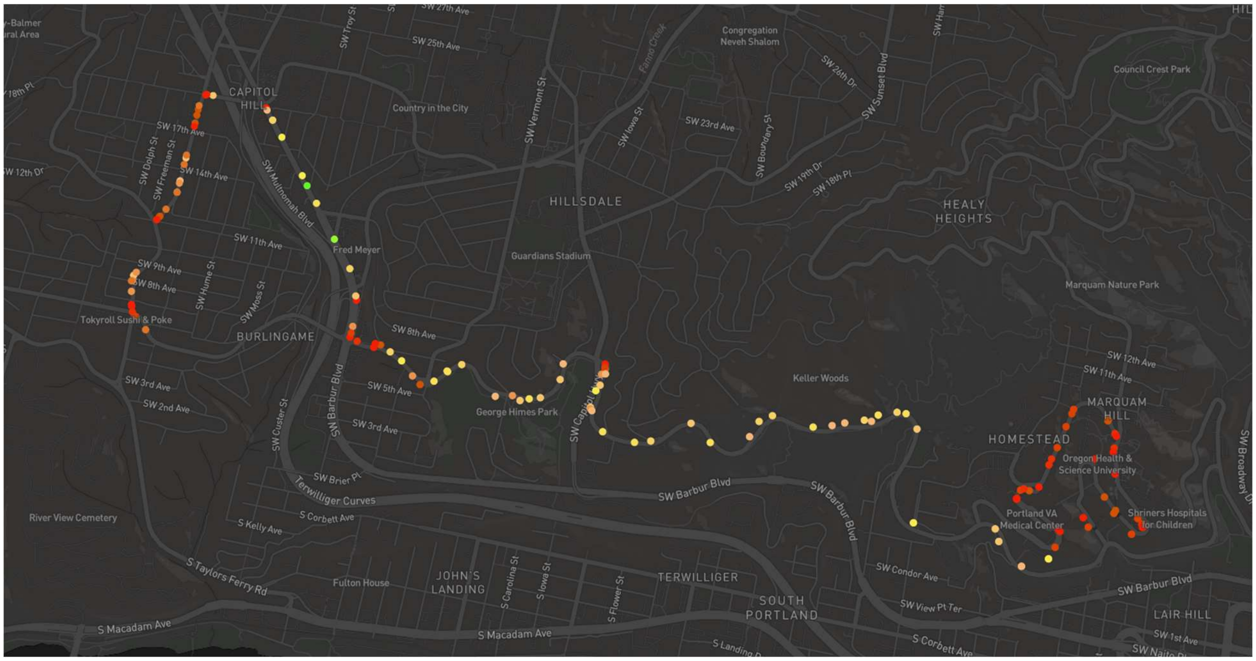


Visualization 2. All outbound trips that occurred on route 65 on any Friday (you choose which Friday) between the hours of 4pm and 6pm.

```
SELECT longitude, latitude, speed FROM breadcrumb b JOIN trip_vw t ON b.trip_id =
t.trip_id WHERE route_id = 65 AND DATE(tstamp) = '2023-01-20' AND EXTRACT(HOUR
FROM tstamp) >= 16 AND EXTRACT(HOUR FROM tstamp) < 18;
```

```
PGPASSWORD='Project@123' psql -h localhost -p 5432 -d postgres -U postgres -c
"SELECT longitude, latitude, speed FROM breadcrumb b JOIN trip_vw t ON b.trip_id =
t.trip_id WHERE route_id = 65 AND DATE(tstamp) = '2023-01-20' AND EXTRACT(HOUR
FROM tstamp) >= 16 AND EXTRACT(HOUR FROM tstamp) < 18;" -o output2.tsv -F '\t' -A
```

The below visualization shows the bus that occurred on route 65 on January 20th, 2023, between the hours of 4pm and 6pm.

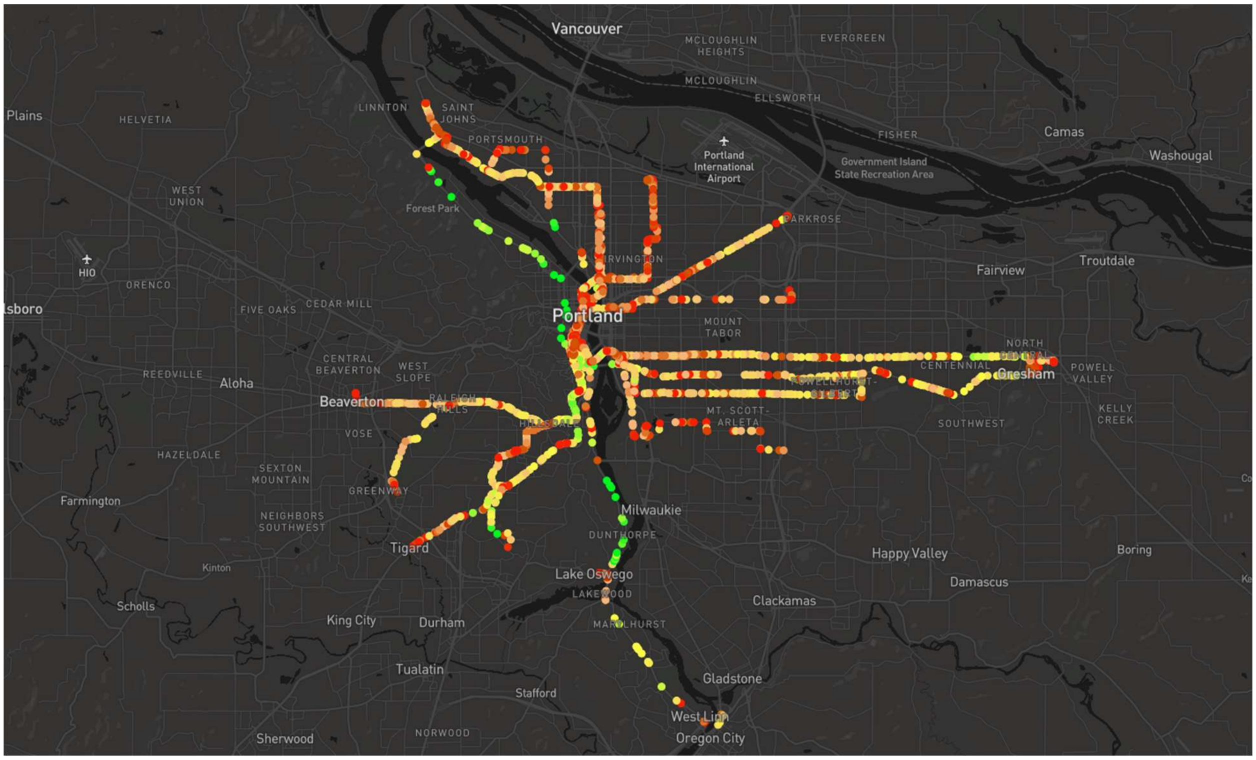


Visualization 3. All trips that travel to and from PSU campus on any Sunday morning (you choose which Sunday) between 9am and 11am.

```
SELECT longitude, latitude, speed FROM breadcrumb WHERE trip_id IN (SELECT trip_id
FROM breadcrumb WHERE latitude BETWEEN 45.5080084 AND 45.5137478 AND longitude
BETWEEN -122.6843533 AND -122.6809583 AND DATE(tstamp) = '2023-01-08' AND
EXTRACT(HOUR FROM tstamp) >= 9 AND EXTRACT(HOUR FROM tstamp) < 11);
```

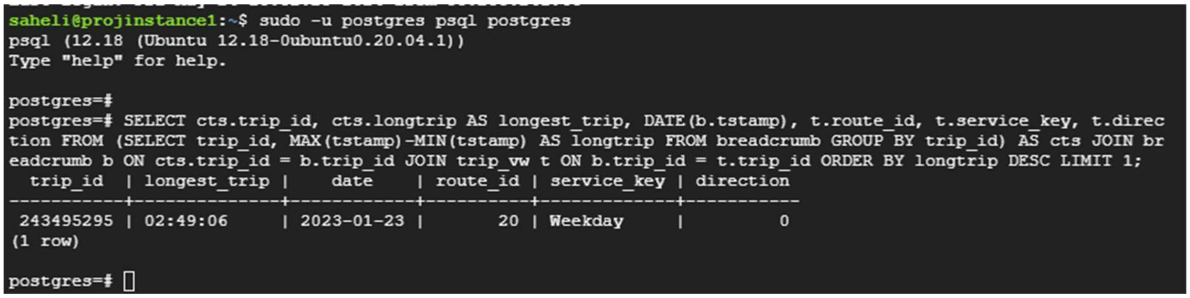
```
PGPASSWORD='Project@123' psql -h localhost -p 5432 -d postgres -U postgres -c
"SELECT longitude, latitude, speed FROM breadcrumb WHERE trip_id IN (SELECT trip_id
FROM breadcrumb WHERE latitude BETWEEN 45.5080084 AND 45.5137478 AND longitude
BETWEEN -122.6843533 AND -122.6809583 AND DATE(tstamp) = '2023-01-08' AND
EXTRACT(HOUR FROM tstamp) >= 9 AND EXTRACT(HOUR FROM tstamp) < 11);" -o
output3.tsv -F '\t' -A
```

The below visualization shows all trips that travel to and from PSU campus on January 08th, 2023, between the hours of 9am and 11am.



Visualization 4. The longest (as measured by time) trip in your entire data set. Indicate the date, route #, and the trip ID of the trip along with a visualization showing the entire trip.

SELECT cts.trip_id, cts.longtrip AS longest_trip, DATE(b.tstamp), t.route_id, t.service_key, t.direction FROM (SELECT trip_id, MAX(tstamp)-MIN(tstamp) AS longtrip FROM breadcrumb GROUP BY trip_id) AS cts JOIN breadcrumb b ON cts.trip_id = b.trip_id JOIN trip_vw t ON b.trip_id = t.trip_id ORDER BY longtrip DESC LIMIT 1;

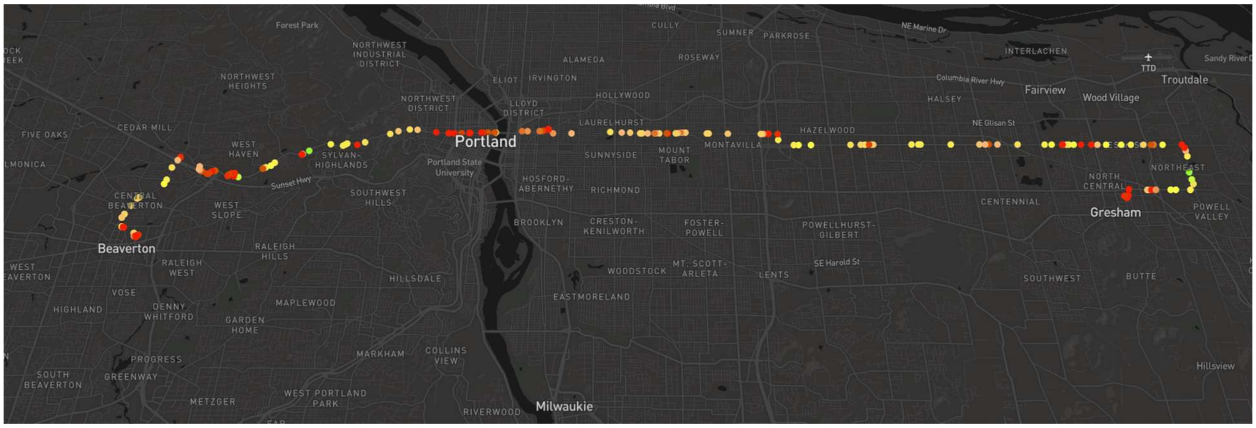


```
saheli@projinstance1:~$ sudo -u postgres psql postgres
psql (12.18 (Ubuntu 12.18-0ubuntu0.20.04.1))
Type "help" for help.

postgres=#
postgres=# SELECT cts.trip_id, cts.longtrip AS longest_trip, DATE(b.tstamp), t.route_id, t.service_key, t.direc
tion FROM (SELECT trip_id, MAX(tstamp)-MIN(tstamp) AS longtrip FROM breadcrumb GROUP BY trip_id) AS cts JOIN br
eadcrumb b ON cts.trip_id = b.trip_id JOIN trip_vw t ON b.trip_id = t.trip_id ORDER BY longtrip DESC LIMIT 1;
  trip_id  | longest_trip |    date    | route_id | service_key | direction
-----------+--------------+------------+----------+-------------+-----------
 243495295 | 02:49:06     | 2023-01-23 |       20 | Weekday     |         0
(1 row)

postgres=# 
```

with cte as (SELECT cts.trip_id, cts.longtrip AS longest_trip, DATE(b.tstamp), t.route_id, t.service_key, t.direction FROM (SELECT trip_id, MAX(tstamp)-MIN(tstamp) AS longtrip FROM breadcrumb GROUP BY trip_id) AS cts JOIN breadcrumb b ON cts.trip_id = b.trip_id JOIN trip_vw t ON b.trip_id = t.trip_id ORDER BY longtrip DESC LIMIT 1)
SELECT longitude, latitude, speed FROM breadcrumb b JOIN trip_vw t ON b.trip_id = t.trip_id WHERE b.trip_id = (select trip_id from cte);

```
PGPASSWORD='Project@123' psql -h localhost -p 5432 -d postgres -U postgres -c "with cte as (SELECT cts.trip_id, cts.longtrip AS longest_trip, DATE(b.tstamp), t.route_id, t.service_key, t.direction FROM (SELECT trip_id, MAX(tstamp)-MIN(tstamp) AS longtrip FROM breadcrumb GROUP BY trip_id) AS cts JOIN breadcrumb b ON cts.trip_id = b.trip_id JOIN trip_vw t ON b.trip_id = t.trip_id ORDER BY longtrip DESC LIMIT 1)
SELECT longitude, latitude, speed FROM breadcrumb b JOIN trip_vw t ON b.trip_id = t.trip_id WHERE b.trip_id = (select trip_id from cte);
" -o output4.tsv -F '\t' -A
```

The below visualization shows the longest trip in entire data set and January 23rd, 2023, is having the longest trip with trip_id 243495295.

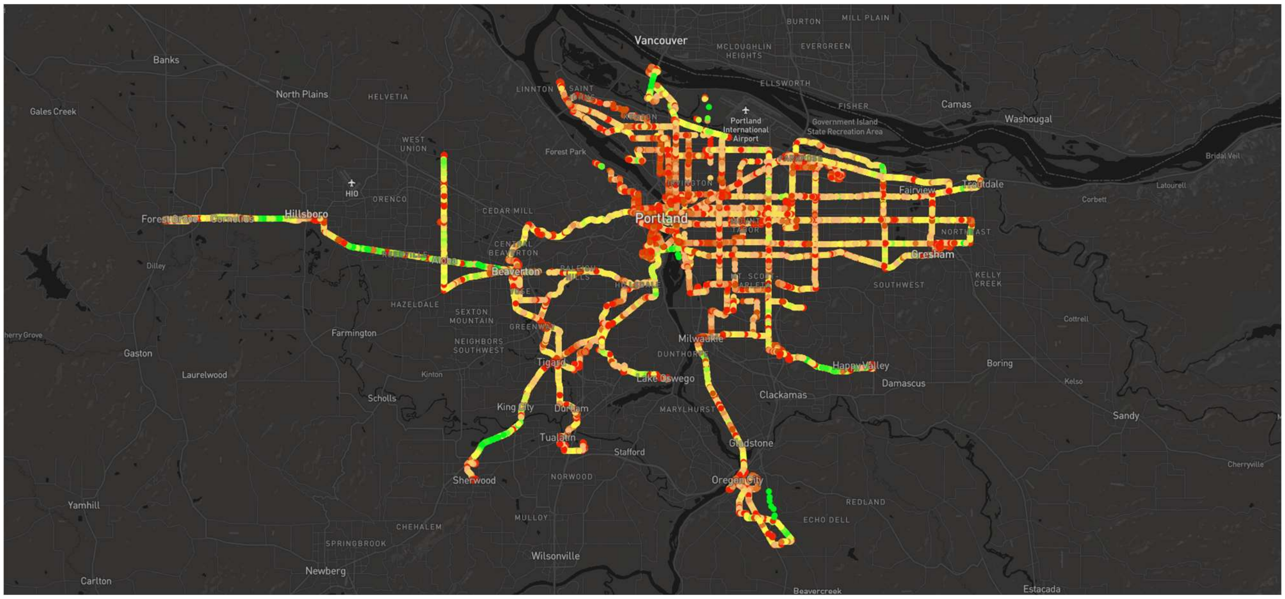


Visualization 5a, 5b, 5c, …. Three or more additional visualizations of your choice. Indicate why you chose each particular visualization.

5a. We want to know all the bus services provided in one day and how far all the bus services are provided in every direction. For this visualization we have selected a specific weekday and collected all the stop points and from there we have collected its latitude and longitude points.

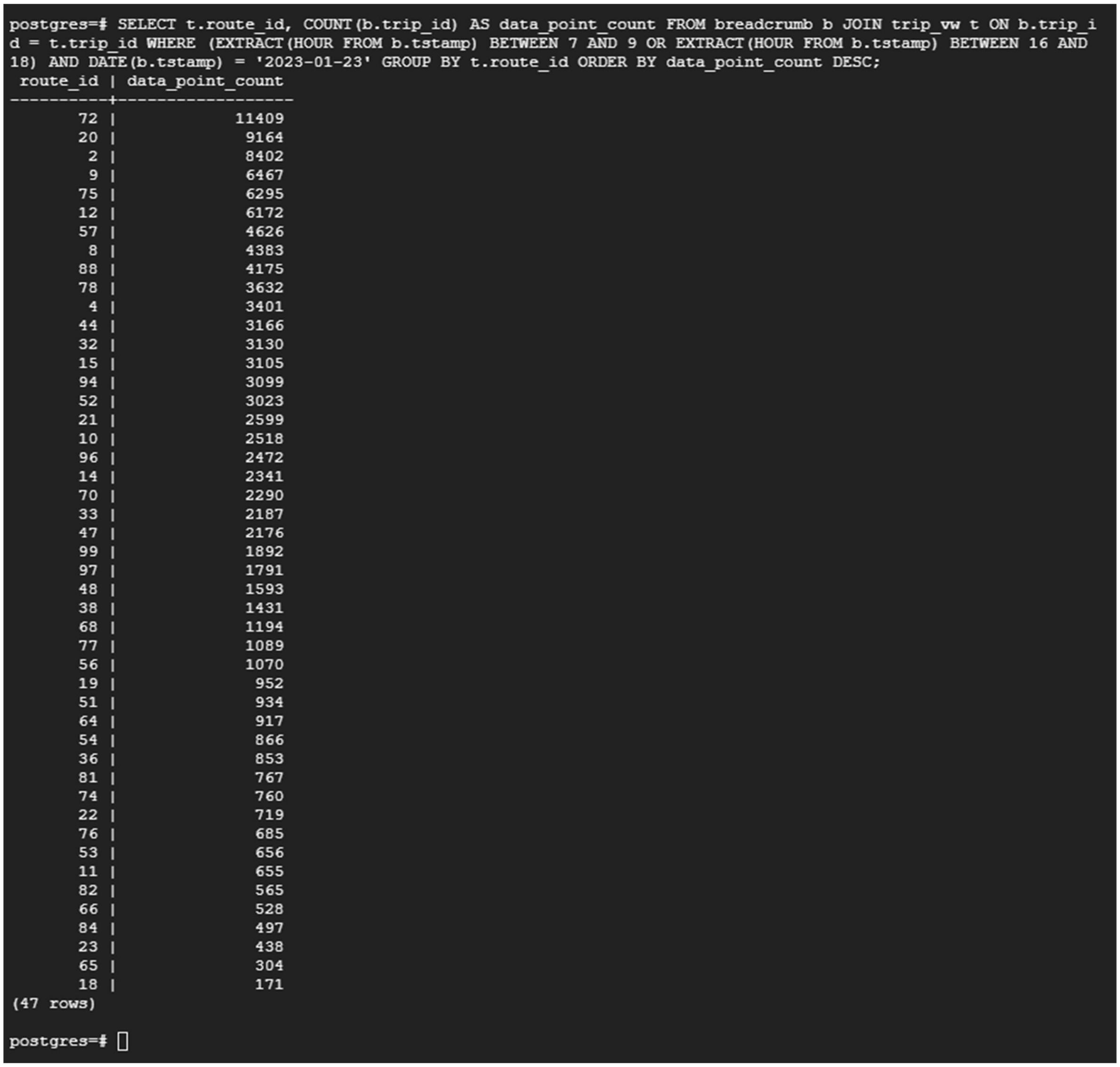
```
select longitude, latitude, speed from breadcrumb b join trip_vw t on b.trip_id = t.trip_id where DATE(b.tstamp) = '2023-01-21' order by b.tstamp;
```

```
PGPASSWORD='Project@123' psql -h localhost -p 5432 -d postgres -U postgres -c "select longitude, latitude, speed from breadcrumb b join trip_vw t on b.trip_id = t.trip_id where DATE(b.tstamp) = '2023-01-21' order by b.tstamp;" -o output5a.tsv -F '\t' -A
```



5b. We want to Identify Busiest Routes During Peak Hours i.e. from morning 7:00 AM to 9:00 AM and evening 4:00 PM to 6:00 PM. The query below identifies the routes with the most data points during peak hours (e.g., 7-9 AM and 4-6 PM). We did visualization by collecting the latitude and longitude points of the routes which are busy during peak hours. By this visualization we understood the routes which are too busy during peak hours. From the observations I found the downtown is so busy during peak hours which is obvious.

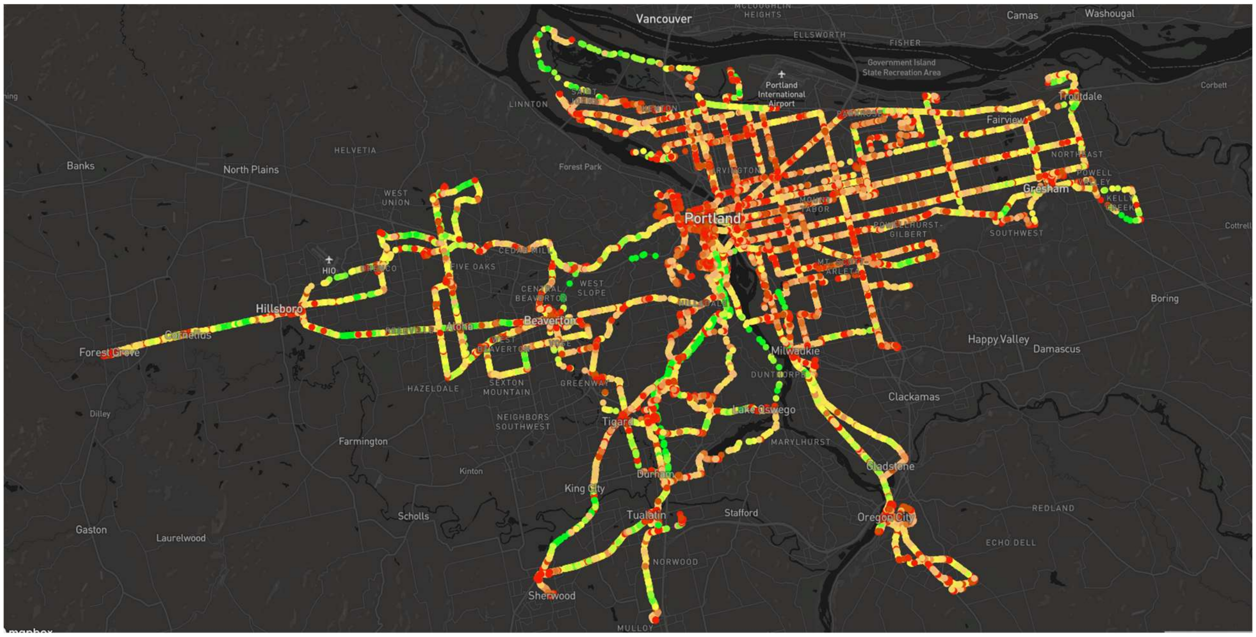
```
SELECT t.route_id, COUNT(b.trip_id) AS data_point_count FROM breadcrumb b JOIN
trip_vw t ON b.trip_id = t.trip_id WHERE (EXTRACT(HOUR FROM b.tstamp) BETWEEN 7
AND 9 OR EXTRACT(HOUR FROM b.tstamp) BETWEEN 16 AND 18) AND DATE(b.tstamp)
= '2023-01-23' GROUP BY t.route_id ORDER BY data_point_count DESC;
```



```
postgres=# SELECT t.route_id, COUNT(b.trip_id) AS data_point_count FROM breadcrumb b JOIN trip_vw t ON b.trip_i
d = t.trip_id WHERE (EXTRACT(HOUR FROM b.tstamp) BETWEEN 7 AND 9 OR EXTRACT(HOUR FROM b.tstamp) BETWEEN 16 AND
18) AND DATE(b.tstamp) = '2023-01-23' GROUP BY t.route_id ORDER BY data_point_count DESC;
 route_id | data_point_count
----------+------------------
       72 |            11409
       20 |             9164
        2 |             8402
        9 |             6467
       75 |             6295
       12 |             6172
       57 |             4626
        8 |             4383
       88 |             4175
       78 |             3632
        4 |             3401
       44 |             3166
       32 |             3130
       15 |             3105
       94 |             3099
       52 |             3023
       21 |             2599
       10 |             2518
       96 |             2472
       14 |             2341
       70 |             2290
       33 |             2187
       47 |             2176
       99 |             1892
       97 |             1791
       48 |             1593
       38 |             1431
       68 |             1194
       77 |             1089
       56 |             1070
       19 |              952
       51 |              934
       64 |              917
       54 |              866
       36 |              853
       81 |              767
       74 |              760
       22 |              719
       76 |              685
       53 |              656
       11 |              655
       82 |              565
       66 |              528
       84 |              497
       23 |              438
       65 |              304
       18 |              171
(47 rows)

postgres=# 
```

SELECT longitude, latitude, speed FROM breadcrumb b JOIN trip_vw t ON b.trip_id = t.trip_id WHERE (EXTRACT(HOUR FROM b.tstamp) BETWEEN 7 AND 9 OR EXTRACT(HOUR FROM b.tstamp) BETWEEN 16 AND 18) AND DATE(b.tstamp) = '2023-01-23' ;

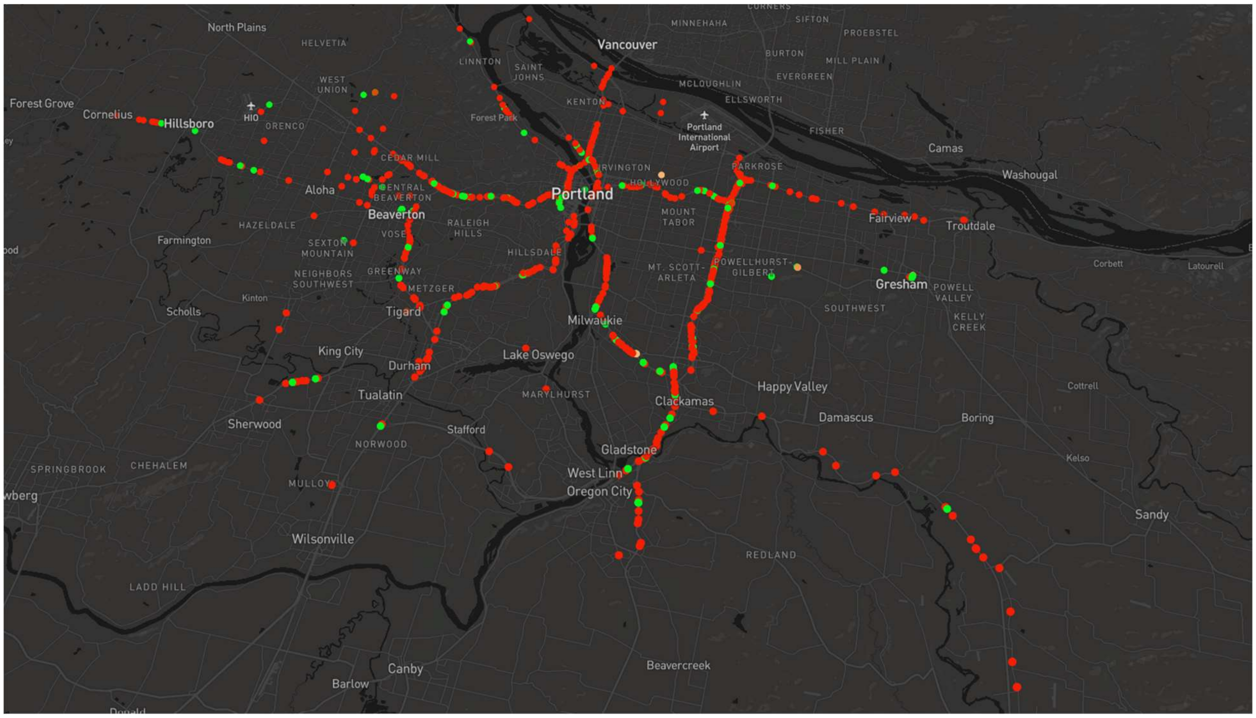
PGPASSWORD='Project@123' psql -h localhost -p 5432 -d postgres -U postgres -c "SELECT longitude, latitude, speed FROM breadcrumb b JOIN trip_vw t ON b.trip_id = t.trip_id WHERE (EXTRACT(HOUR FROM b.tstamp) BETWEEN 7 AND 9 OR EXTRACT(HOUR FROM b.tstamp) BETWEEN 16 AND 18) AND DATE(b.tstamp) = '2023-01-23' ;" -o output5b.tsv -F '\t' -A



5c. We want to identify and retrieve the geographical locations (longitude and latitude) and corresponding speeds of a bus from the breadcrumb table where there were significant changes in speed. Specifically, it looks for instances where the speed difference between consecutive records within the same trip exceeds 20 units (either increase or decrease). The result helps in visualizing areas and times where abrupt speed changes occurred, which could indicate events such as rapid acceleration, sudden braking, or other anomalies during the trip.

```
WITH SpeedChanges AS (SELECT longitude, latitude, trip_id, tstamp, speed, LAG(speed)
OVER (PARTITION BY trip_id ORDER BY tstamp) AS previous_speed,speed - LAG(speed)
OVER (PARTITION BY trip_id ORDER BY tstamp) AS speed_change FROM breadcrumb
where latitude <> 'NaN' AND longitude <> 'NaN')
SELECT longitude, latitude, speed FROM SpeedChanges WHERE ABS(speed_change) >
20;
```

```
PGPASSWORD='Project@123' psql -h localhost -p 5432 -d postgres -U postgres -c "WITH
SpeedChanges AS (SELECT longitude, latitude, trip_id, tstamp, speed, LAG(speed) OVER
(PARTITION BY trip_id ORDER BY tstamp) AS previous_speed,speed - LAG(speed) OVER
(PARTITION BY trip_id ORDER BY tstamp) AS speed_change FROM breadcrumb where
latitude <> 'NaN' AND longitude <> 'NaN')
SELECT longitude, latitude, speed FROM SpeedChanges WHERE ABS(speed_change) >
20;" -o output5d.tsv -F '\t' -A
```



Your Code

Provide a reference to the repository where you store your python code. If you are keeping it private then share it with the Professor (rbi@pdx.edu or mina8@pdx.edu) and TA (vysali@pdx.edu).