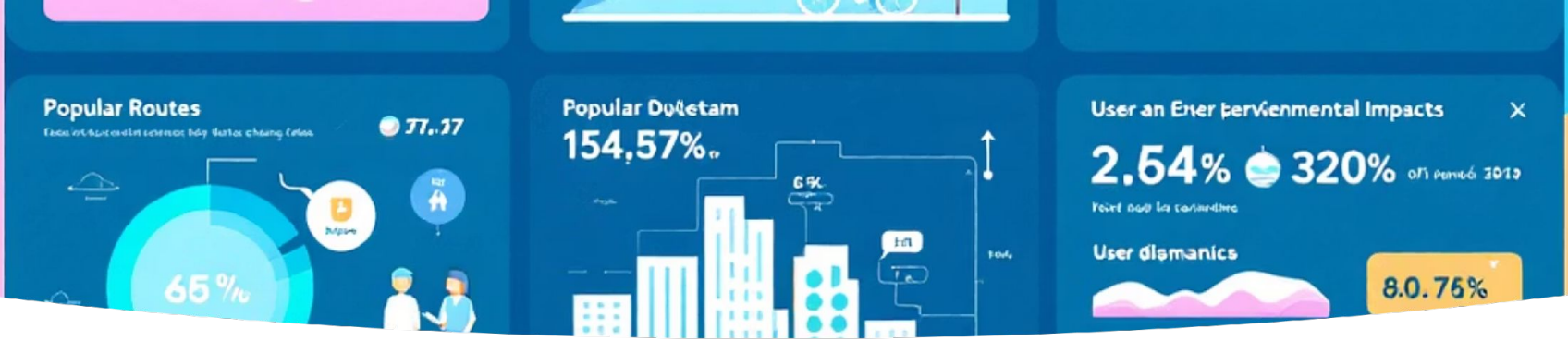
BikeFlow Analytics: Data Engineering Project

A comprehensive data warehouse solution for optimizing bike-sharing operations

By Layashree Adepu



Project Objective

Primary Goal

Analyze the relationship between bike availability and utilization patterns in popular urban areas

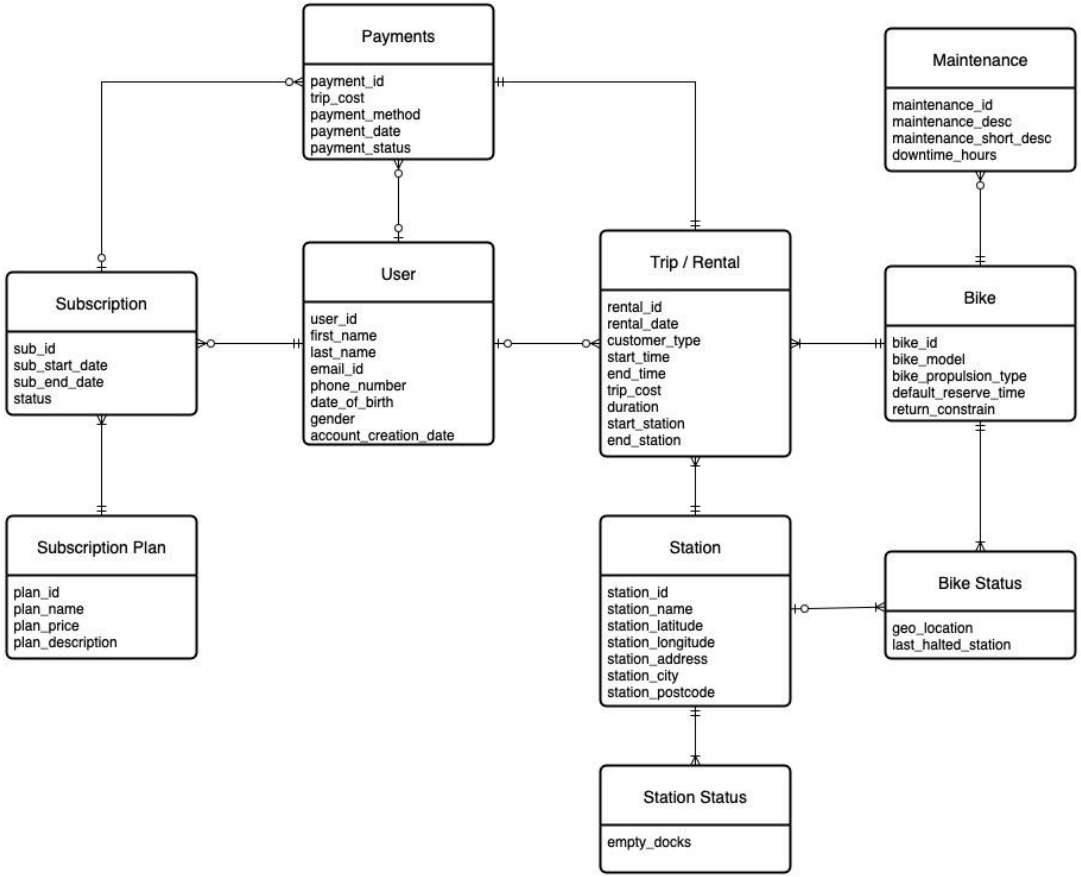
Key Insights

Determine if popular locations have enough bikes to meet demand and identify underutilized areas

Business Impact

Optimize bike distribution strategies to maximize operational efficiency and user satisfaction

Conceptual Diagram



wheels | lyft BIKES

Overview Register/Sign In Map Meet Our Bikes Plans & pricing Bi

System Data

Here you'll find Bay Wheels's trip data for public use. So whether you're a designer, devel
bring it to life. This data is provided according to the Bay Wheels License Agreement.

The Data

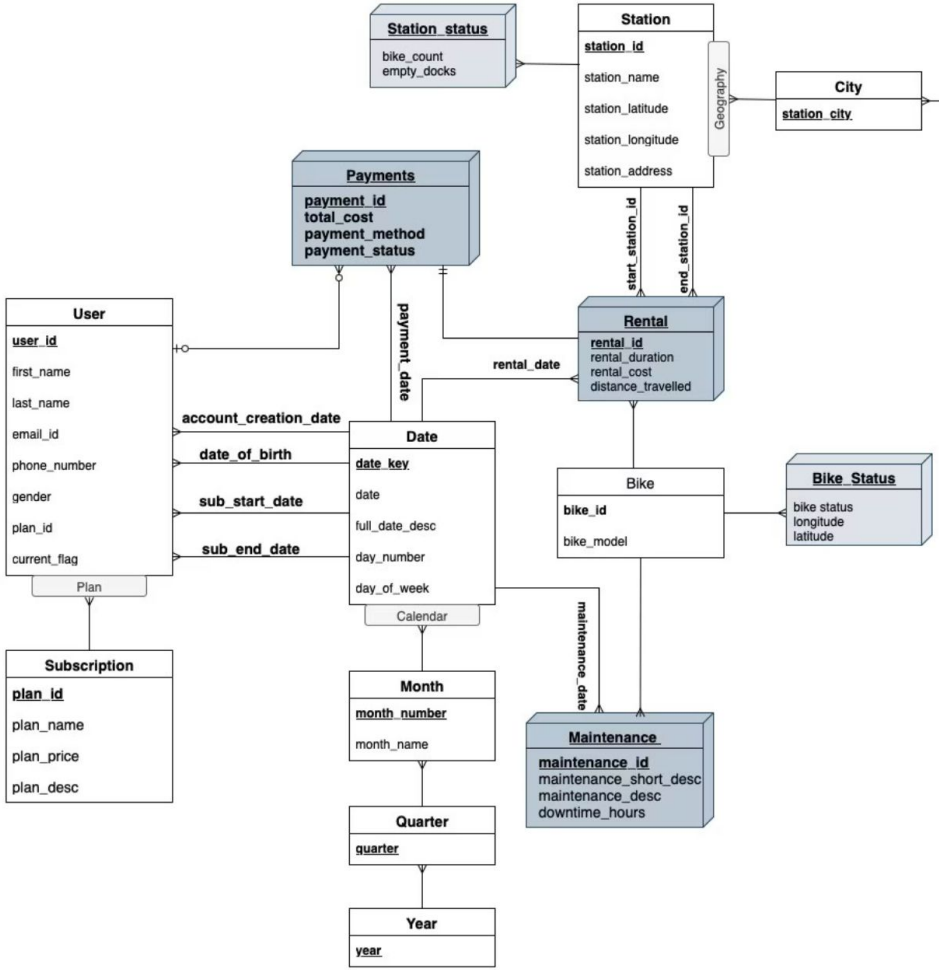
Each trip is anonymized and includes:

- Trip Duration (seconds)
- Start Time and Date
- End Time and Date
- Start Station ID
- Start Station Name
- Start Station Latitude
- Start Station Longitude
- End Station ID
- End Station Name
- End Station Latitude
- End Station Longitude
- Ride ID
- User Type (Subscriber or Customer – "Subscriber" = Member or "Customer" = Casu

Download Bay Wheels trip history data

Real-Time Data

Bay Wheels publishes real-time system data in General Bikeshare Feed Specification forn



Design Implementation Steps

01 **Conceptual Diagram**

The goal is to create a high-level representation focuses on identifying key entities, their attributes, and the relationships between them, independent of any technology

02 **Logical Diagram**

It involves mapping the entities and relationships to logical constructs like tables and columns, defining primary and foreign keys, and incorporating data types.

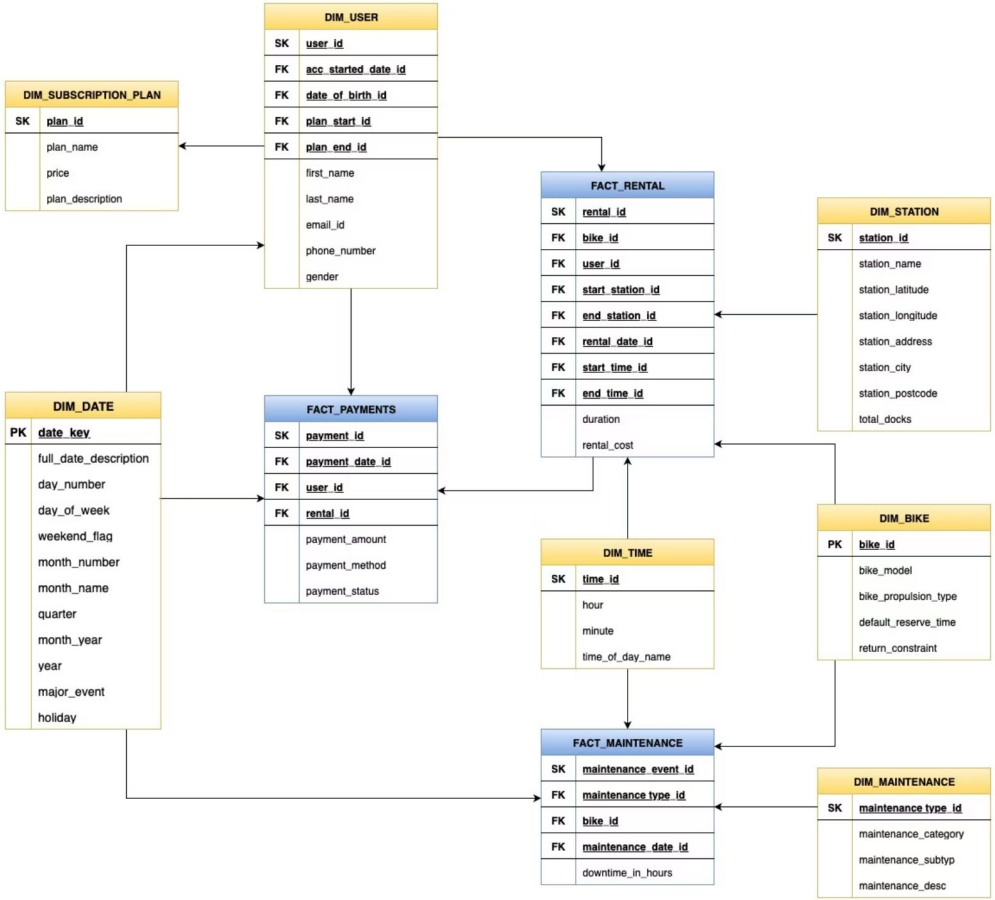
03 **MultiDim Conceptual Diagram**

It involves identifying key business metrics (facts) and the dimensions (e.g., time, location, user, bike) by which these metrics can be analyzed. The goal is to create a star or snowflake schema that optimizes data retrieval.

04 **MultiDim Logical Diagram**

This includes defining the exact structure of fact and dimension tables, specifying aggregation rules, and planning for data transformations.

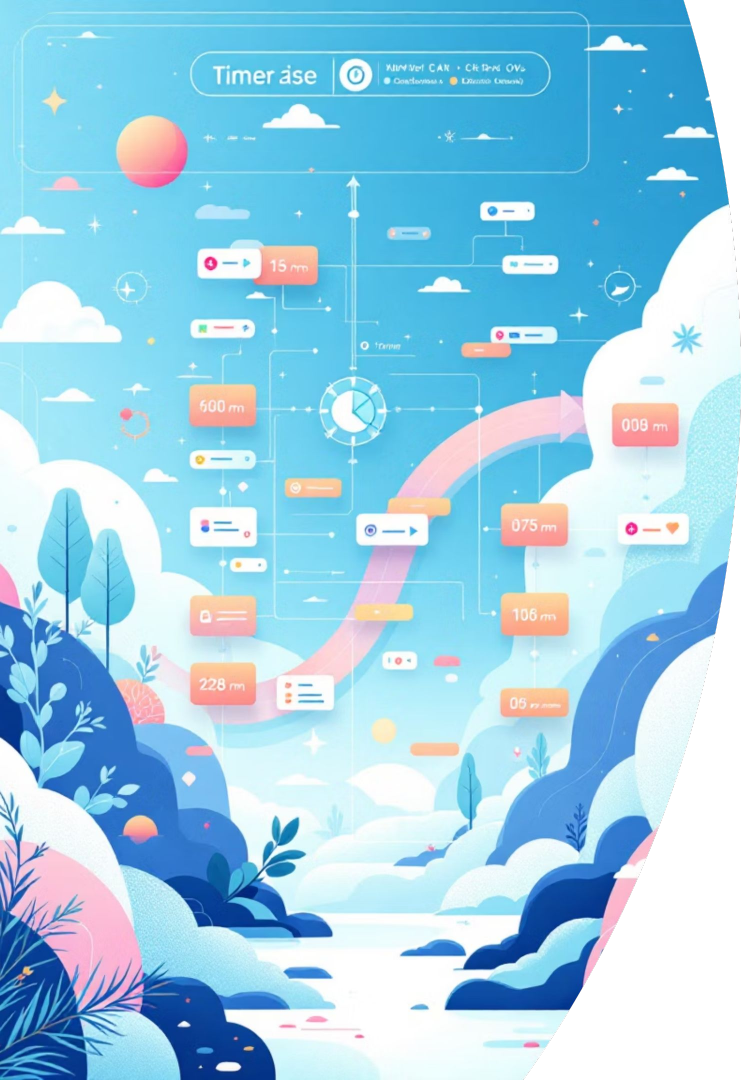
Data Warehouse Model



Star Schema Design

Our dimensional model features a central fact table surrounded by dimension tables for optimal query performance and business intelligence reporting.

- Fact table: Trip and availability metrics
- Time dimensions: Date and time hierarchies
- Location dimensions: Station and geographic data
- Bike dimensions: Vehicle characteristics



Time Dimension Implementation

DIM_TIME Structure

Granular time tracking with minute-level precision, including time-of-day categorization for pattern analysis

- Hour and minute extraction
- Time period classification
- Peak hour identification

DIM_DATE Features

Comprehensive date dimension spanning decades with business calendar support and holiday tracking

- Weekend and holiday flags
- Quarter and month hierarchies
- Custom business periods

DIM_TIME

```
INSERT INTO DIM_TIME (
  time_of_day,
  hour,
  minute,
  time_of_day_name
)
SELECT
  (t::timestamp)::time AS time_of_day,
  EXTRACT(HOUR FROM t) AS hour,
  EXTRACT(MINUTE FROM t) AS minute,
  CASE
    WHEN EXTRACT(HOUR FROM t) BETWEEN 5 AND 11 THEN
'Morning'
    WHEN EXTRACT(HOUR FROM t) BETWEEN 12 AND 16 THEN
'Afternoon'
    WHEN EXTRACT(HOUR FROM t) BETWEEN 17 AND 20 THEN
'Evening'
    ELSE 'Night'
  END AS time_of_day_name
FROM
  GENERATE_SERIES('2025-01-01 00:00:00'::timestamp,
'2025-01-01 23:59:00'::timestamp, '1 minute'::interval) AS t;
```

DIM_DATE

```
INSERT INTO DIM_DATE
( date_key,full_date,day_number,day_of_week,weekend_flag,m
onth_number,month_name,quarter,month_year, year, holiday)
SELECT
  CAST(TO_CHAR(date_series, 'MMDDYYYY') AS INT)
AS date_key,
  date_series AS full_date,
  EXTRACT(DAY FROM date_series) AS day_number,
  TRIM(TO_CHAR(date_series, 'Day')) AS day_of_week,
  CASE
    WHEN EXTRACT(DOW FROM date_series) IN (0, 6) THEN
TRUE
    ELSE FALSE
  END AS weekend_flag,
  EXTRACT(MONTH FROM date_series) AS month_number,
  TRIM(TO_CHAR(date_series, 'Month')) AS month_name,
  'Q' || EXTRACT(QUARTER FROM date_series) AS quarter,
  TO_CHAR(date_series, 'YYYY-MM') AS month_year,
  EXTRACT(YEAR FROM date_series) AS year,
  CASE
    WHEN date_series = '2025-01-01' THEN 'New Year's Day'
    WHEN date_series = '2025-12-25' THEN 'Christmas Day
```

Other Dimensions Implementation

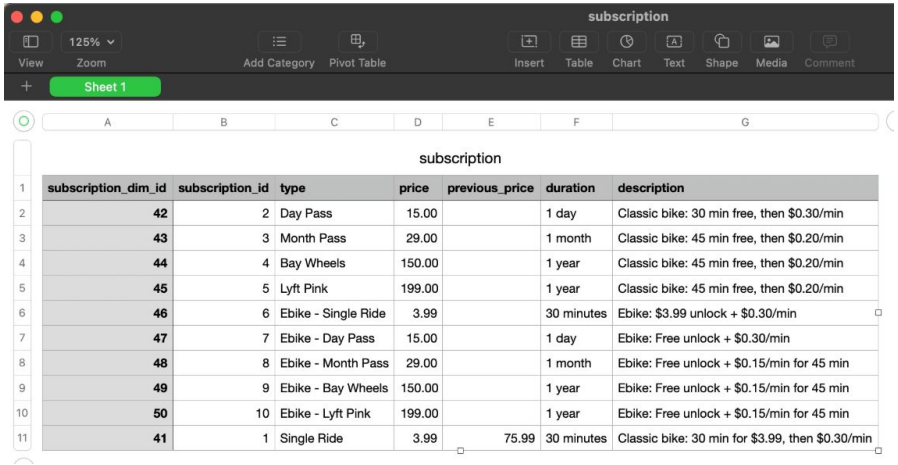
Pricing and operational data sourced from Lyft Bay Wheels API

https://www.lyft.com/bikes/bay-wheels/pricing

Compare your options

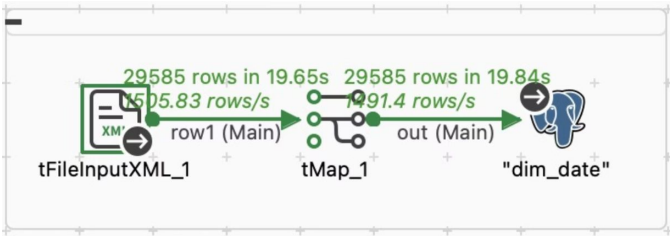
They're all good ones.

	Single ride	Day pass	Month pass	Bay Wheels	Lyft Pink
	$3.99	$15/day	$29/month	$150/year	$199/year
	Get the app →	Get a day pass →	Get a month pass →	Join →	Join →
Classic bike prices	30 min for $3.99, then $0.30/min	30 min free, then $0.30/min	45 min free, then $0.20/min	45 min free, then $0.20/min	45 min free, then $0.20/min
Ebike prices	$3.99 unlock + $0.30/min	Free unlocks + $0.30/min	Free unlocks + $0.15/min for 45 min	Free unlocks + $0.15/min for 45 min	Free unlocks + $0.15/min for 45 min

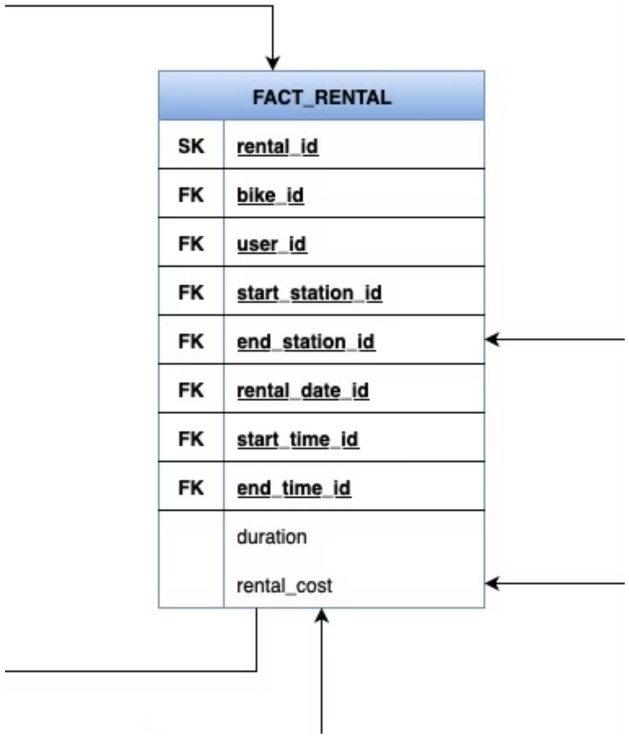


subscription

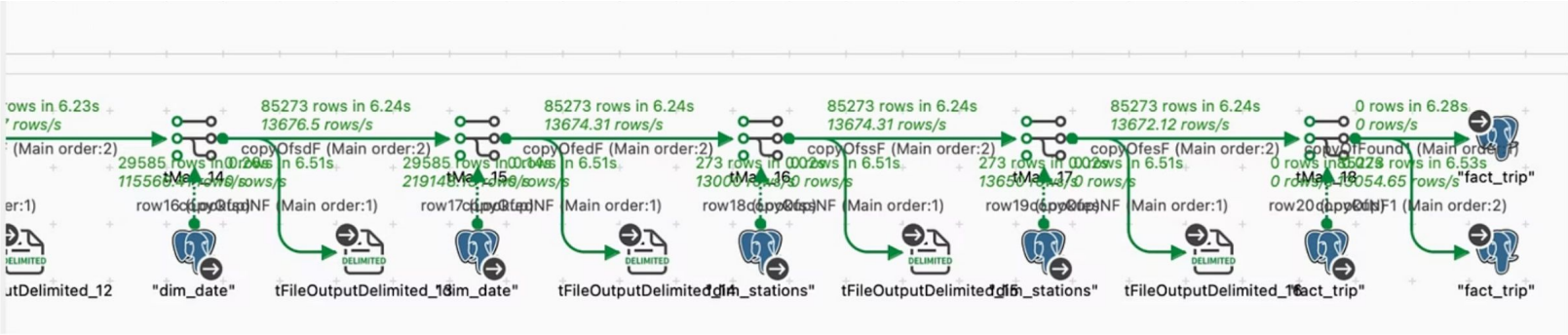
	A	B	C	D	E	F	G
1	subscription_dim_id	subscription_id	type	price	previous_price	duration	description
2	42	2	Day Pass	15.00		1 day	Classic bike: 30 min free, then $0.30/min
3	43	3	Month Pass	29.00		1 month	Classic bike: 45 min free, then $0.20/min
4	44	4	Bay Wheels	150.00		1 year	Classic bike: 45 min free, then $0.20/min
5	45	5	Lyft Pink	199.00		1 year	Classic bike: 45 min free, then $0.20/min
6	46	6	Ebike - Single Ride	3.99		30 minutes	Ebike: $3.99 unlock + $0.30/min
7	47	7	Ebike - Day Pass	15.00		1 day	Ebike: Free unlock + $0.30/min
8	48	8	Ebike - Month Pass	29.00		1 month	Ebike: Free unlock + $0.15/min for 45 min
9	49	9	Ebike - Bay Wheels	150.00		1 year	Ebike: Free unlock + $0.15/min for 45 min
10	50	10	Ebike - Lyft Pink	199.00		1 year	Ebike: Free unlock + $0.15/min for 45 min
11	41	1	Single Ride	3.99	75.99	30 minutes	Classic bike: 30 min for $3.99, then $0.30/min

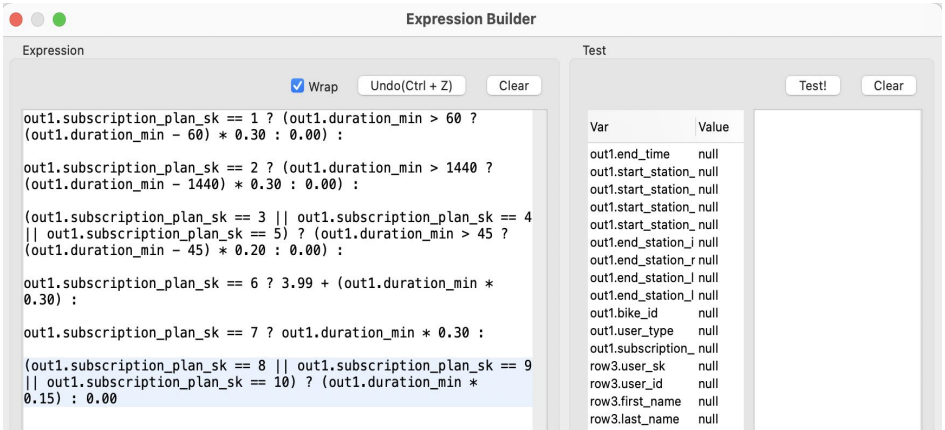


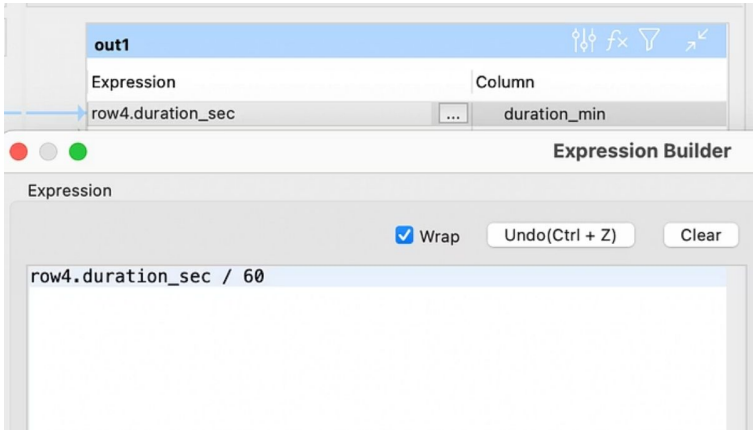
FACT TABLE Focus



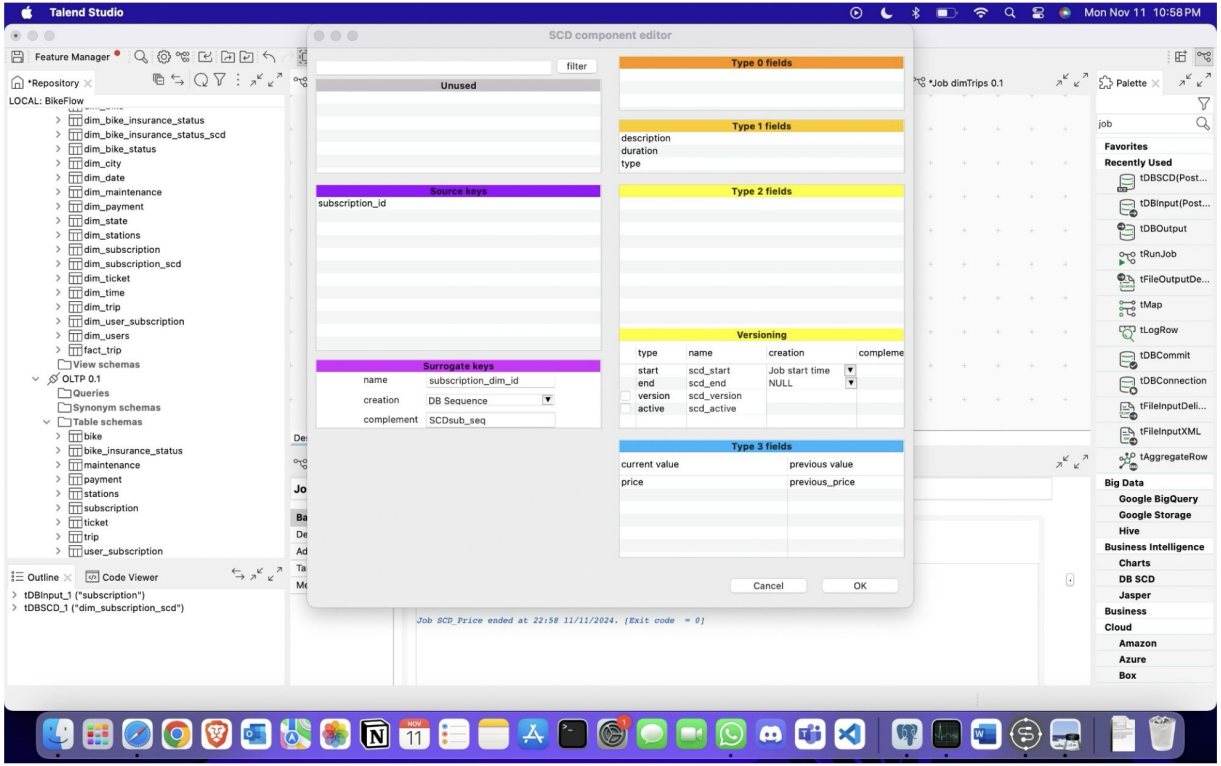
FACT TABLE Implementation







SCD TYPE 3 implementation



subscription_id integer	type character varying (50)	price numeric (10,2)	previous_price numeric (10,2)
2	Day Pass	15.00	[null]
3	Month Pass	29.00	[null]
4	Bay Wheels	150.00	[null]
5	Lyft Pink	199.00	[null]
6	Ebike - Single Ride	3.99	[null]
7	Ebike - Day Pass	15.00	[null]
8	Ebike - Month Pass	29.00	[null]
9	Ebike - Bay Wheels	150.00	[null]
10	Ebike - Lyft Pink	199.00	[null]
1	Single Ride	5.99	5.00

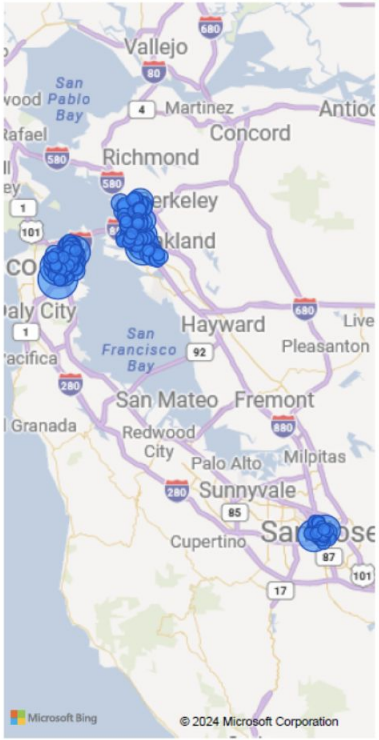
Bike Flow Analytics

1739
No of active users

73.55K
Total amount earned till date

85.27K
Num of trips till date

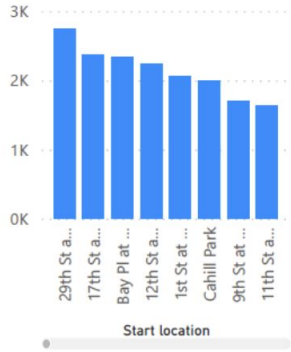
Most popular stations



Stations
West St at 40th St
West Oakland BART Station
Webster St at O'Farrell St
Webster St at Grove St
Webster St at 19th St
Washington St at Kearny St
W St John St at Guadalupe River Trail
Valencia St at 24th St
Valencia St at 22nd St
Valencia St at 16th St
University Ave at Oxford St
Union St at 10th St

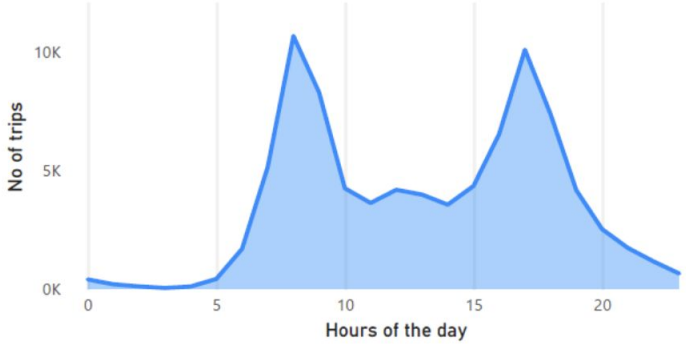
No of bikes under maintenance by Last location of bike

No of trips by Start location



Sum of user_id by gender

Total Trips by Hour of the Day



Sum of amount by type