Northeastern University

Milestone 7

IE 7374 Data Warehousing and Business Intelligence

Spring 2024

Team Member's List

Meet Vasani

Mihir Kakadiya

Formula 1 Race Analysis

Problem Definition

Formula 1, spanning from 1950 to 2017, holds a rich dataset encompassing various aspects of racing. The challenge is to extract valuable insights and optimize strategies based on the provided tables: circuits, constructors, drivers, laptimes, pitstops, qualifying, races, results, seasons, and status.

Key Objectives:

Historical Performance Analysis: Explore the dataset to understand how circuits, constructors, and drivers have evolved over the years. Identify trends, successes, and challenges.

Driver and Constructor Evaluation: Assess the performance of individual drivers and constructors. Identify standout performers, analyze consistency, and determine factors contributing to success or struggle.

Lap Time Optimization: Analyze lap times to identify patterns and areas for improvement. Optimize car setups and strategies to enhance overall performance on different circuits.

Pit Stop Strategies: Evaluate pitstop data to refine strategies. Minimize pitstop times, identify optimal windows for pit stops, and mitigate potential issues.

Qualifying Performance: Understand historical qualifying data to analyze team and driver capabilities in securing favorable starting positions. Identify trends that correlate with race performance.

Race Outcomes and Points Distribution: Analyze race results and points earned to understand the impact of different factors on overall standings. Identify instances of strategic brilliance or missed opportunities.

Seasonal Trends and Performance: Examine data across seasons to identify overarching trends, challenges, and successes. Pinpoint seasons with exceptional team or driver performances.

Real-time Decision Support: Leverage real-time status data to simulate scenarios during races. Develop decision support mechanisms for teams to adapt strategies based on changing conditions.

Dataset Attributes

Circuits: Different circuit names with their location.

Car Constructor: Car constructor name and its location.

Drivers: Driver information.

Laptimes: Different laptimes as per different drivers.

Pitstops: Number of stops as per different race and drivers.

Qualifying: Top 3 qualifying drivers as per different race.

Races: Race details as per circuits.

Results: Results as per all other tables.

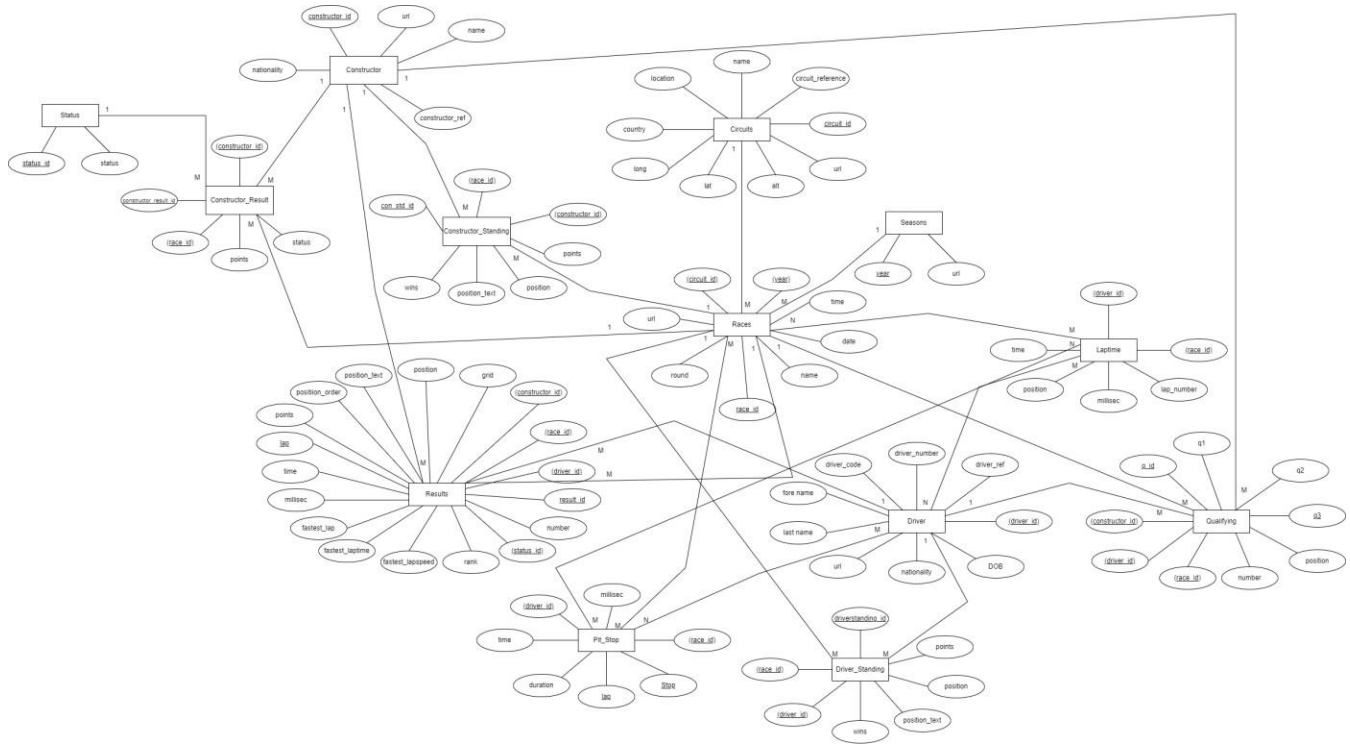
Seasons: A list of every season and corresponding Wikipedia link.Status: A

table of status codes and their status.

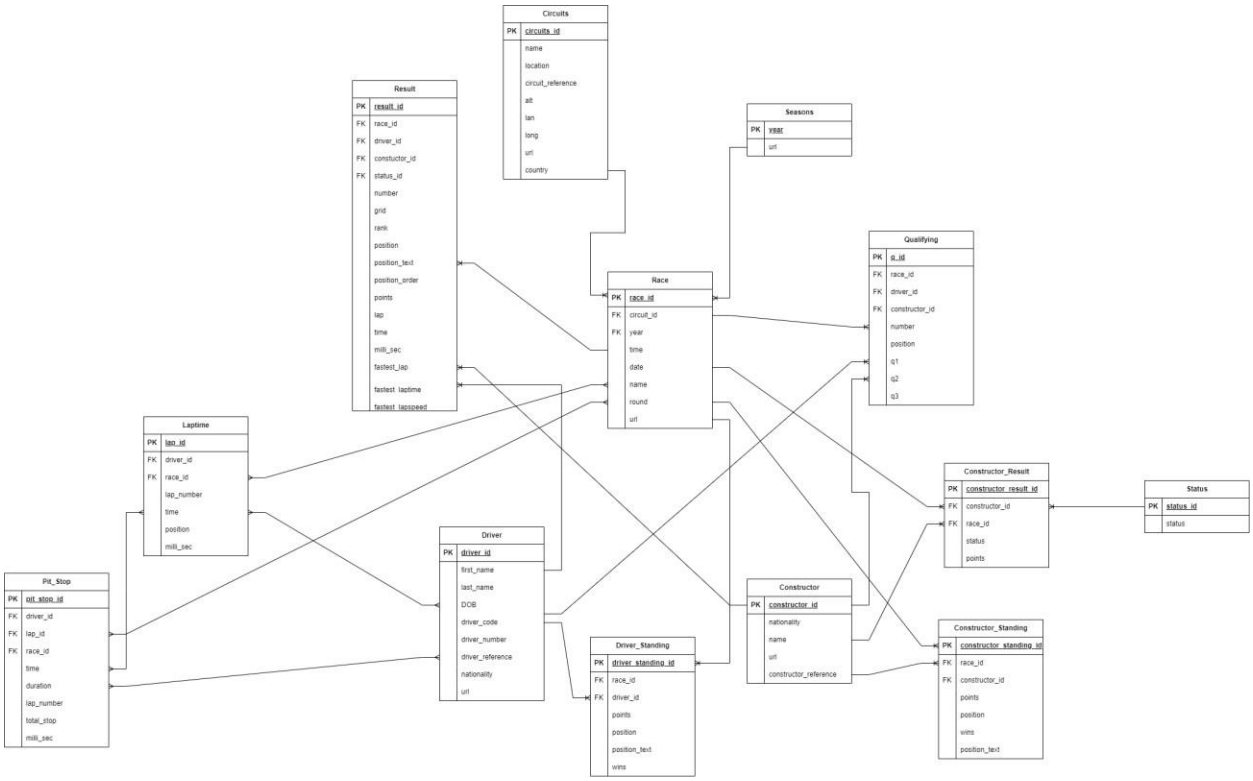
Expected Outputs

The project aims to provide teams, analysts, and enthusiasts with actionable insights derived from historical Formula 1 data. This includes improved decision-making strategies, optimizedcar setups, and a deeper understanding of the factors influencing success in one of the world'spremier racing championships.

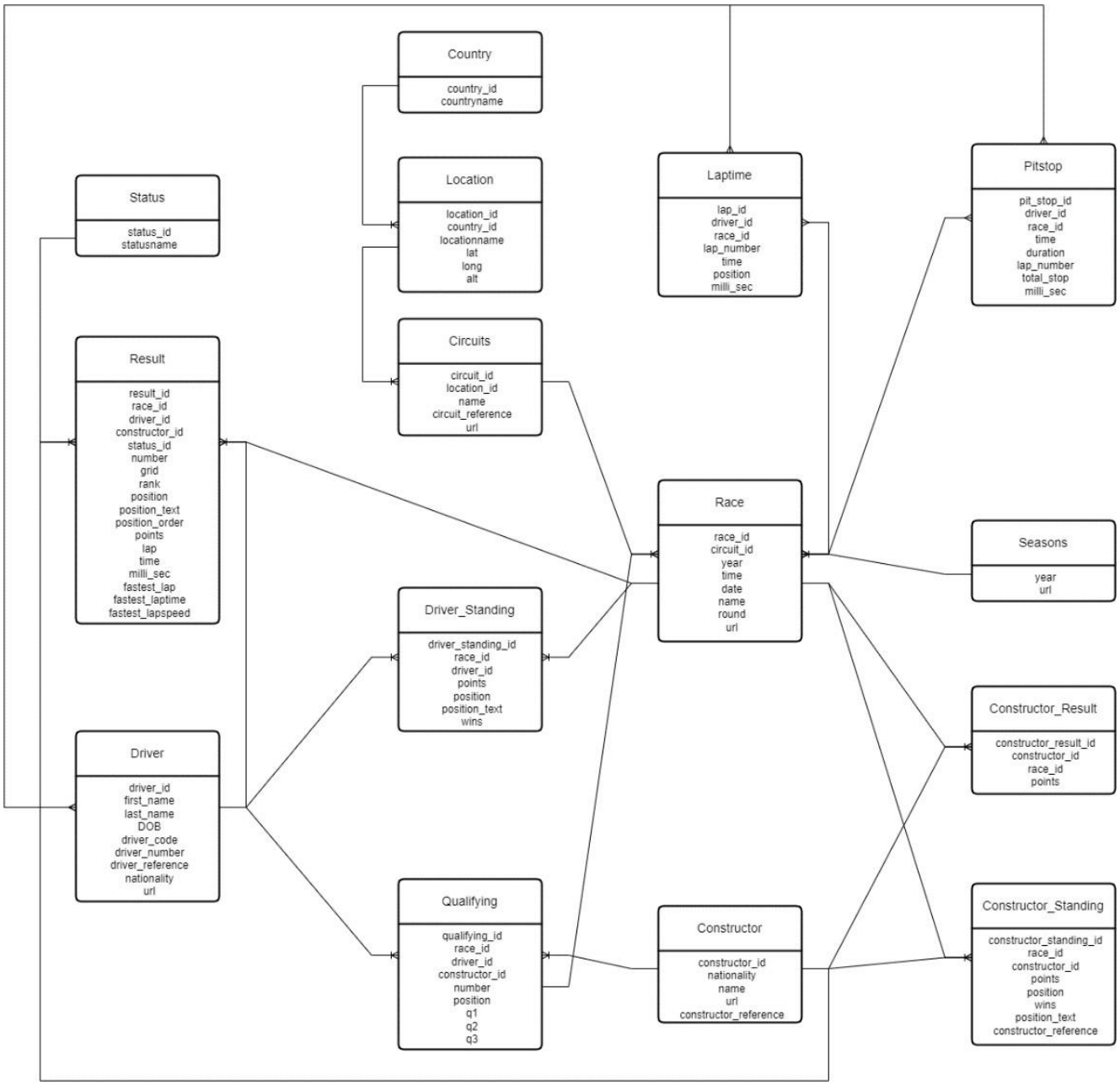
ERD:



Relational Model :



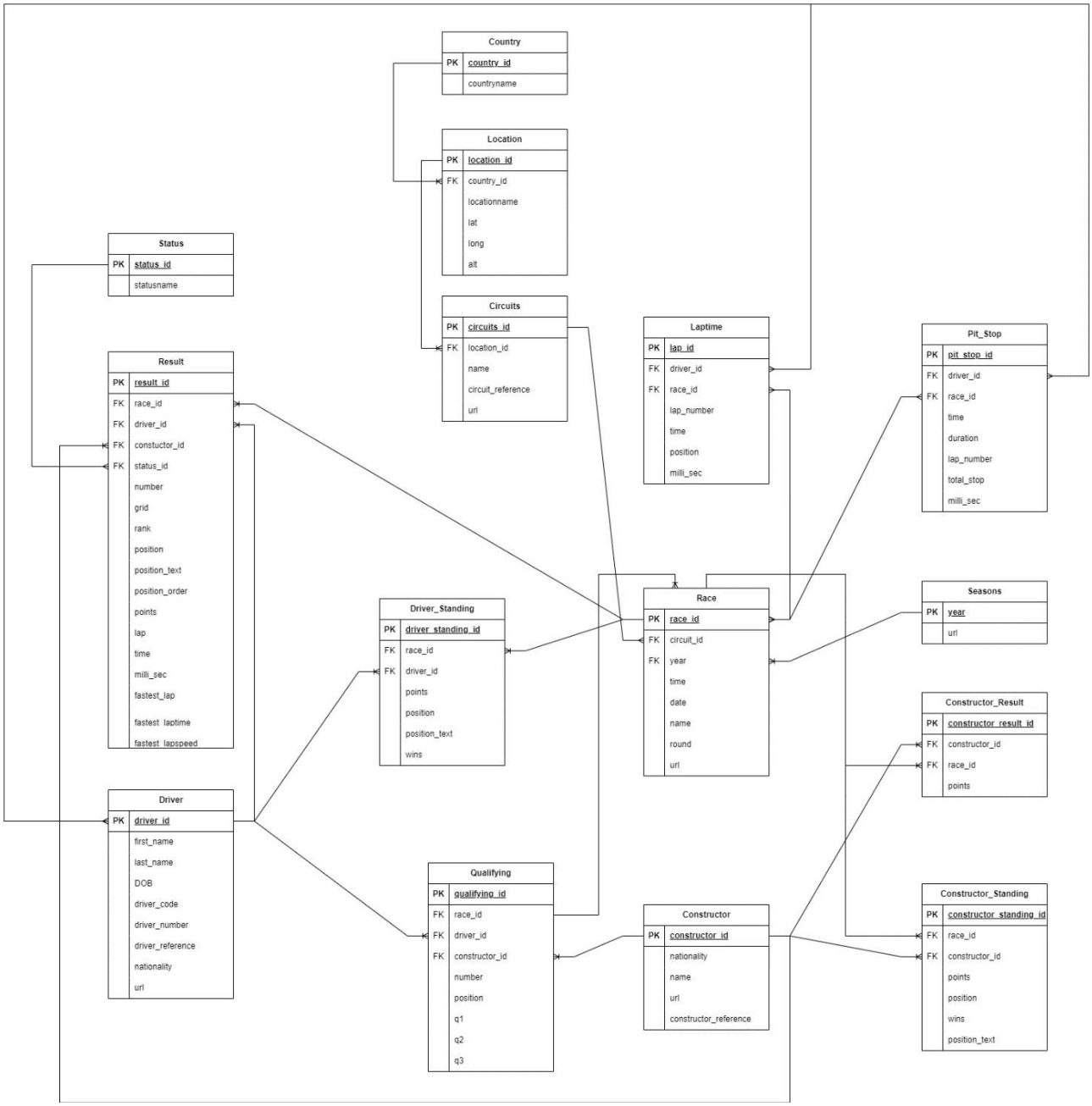
Data Warehouse Model:



Conceptual Model

Possible Hierarchies:

1. Country → Location → Circuits
2. Driver → Driver Standing
3. Constructor → Constructor Standing



Logical Model

OLAP OPERATIONS FOR ANALYSIS :

1. Select avg number of total stops taken by driver whose first name and last name is Nico Rosberg in year 2008.

   OUTPUT 1 ← DICE (F1, driver.first_name = 'Nico AND driver.last_name = 'Rosberg' AND race.year = 2008)

   OUTPUT ← ROLLUP * (OUTPUT 1, F1 → F1, AVG (total_stop) AS avg_stops)

2. Total number of Constructor who took part in year 2009 at Germany.

   OUTPUT 2 ← DICE (F1, race.year = 2009 AND circuit.country = 'Germany')

   OUTPUT ← ROLLUP * (OUTPUT 2, F1 → F1, COUNT (constructor.id) AS total_constructor)

3. SELECT drivers who qualified in year 2009 at Italian Grand Prix.

   OUTPUT ← DICE (F1, race.year = 2009 AND circuit.name = "Italian Grand Prix")

4. SELECT and sort the ranks of drivers in Ascending order for the race played at Turkish Grand Prix in year 2008.

   OUTPUT 4 ← DICE (F1, race.year = 2008 AND race.name = 'Turkish Grand Prix')

   OUTPUT ← SORT (OUTPUT 4, Result, Rank [ASC])

5. Provide the minimum fastest lap speed for the races played in Malaysia.

   OUTPUT 5 ← DICE (F1, circuit.country = 'Malaysia')

   OUTPUT ← ROLLUP* (OUTPUT 5, F1 → F1, MIN (fastest_lap) as fastest_lap)

6. Find out total race having race name Bahrain Grand Prix

   OUTPUT 6 ← SLICE (F1, Race, race.name = 'Bahrain Grand Prix')

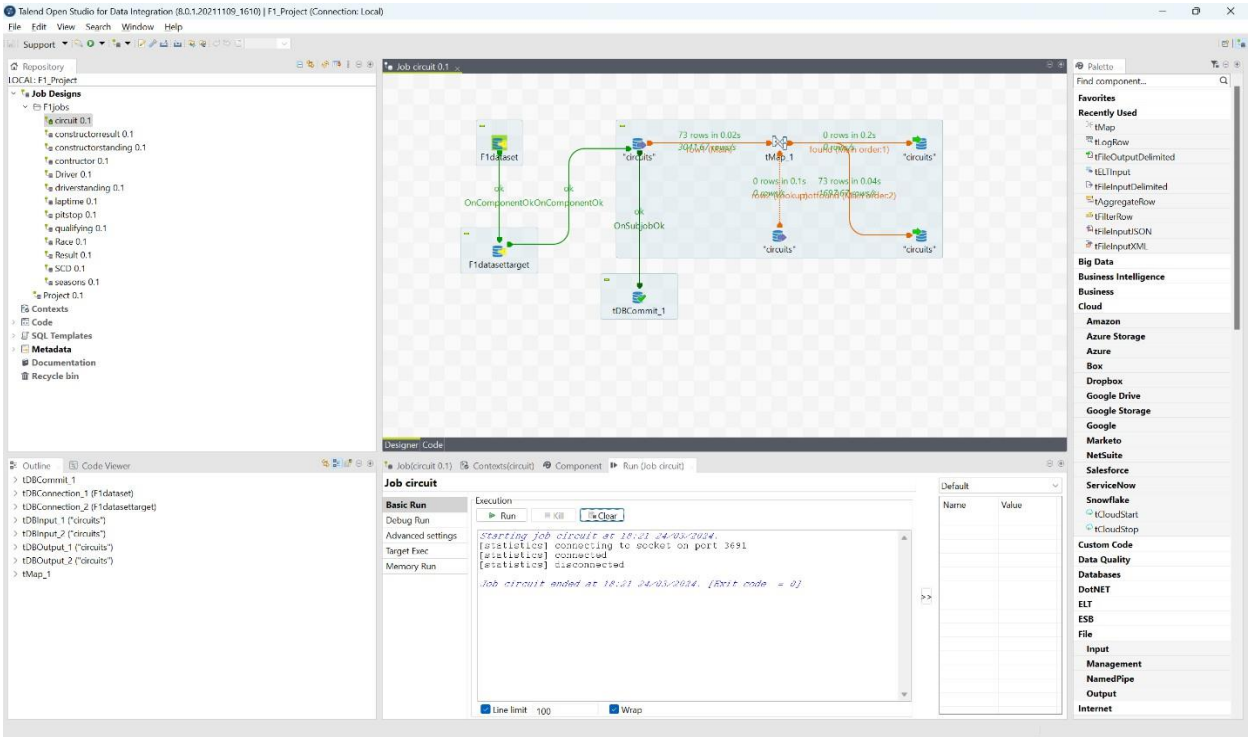
   OUTPUT ← ROLLUP* (OUTPUT 6, Race → Race, COUNT (race_id))

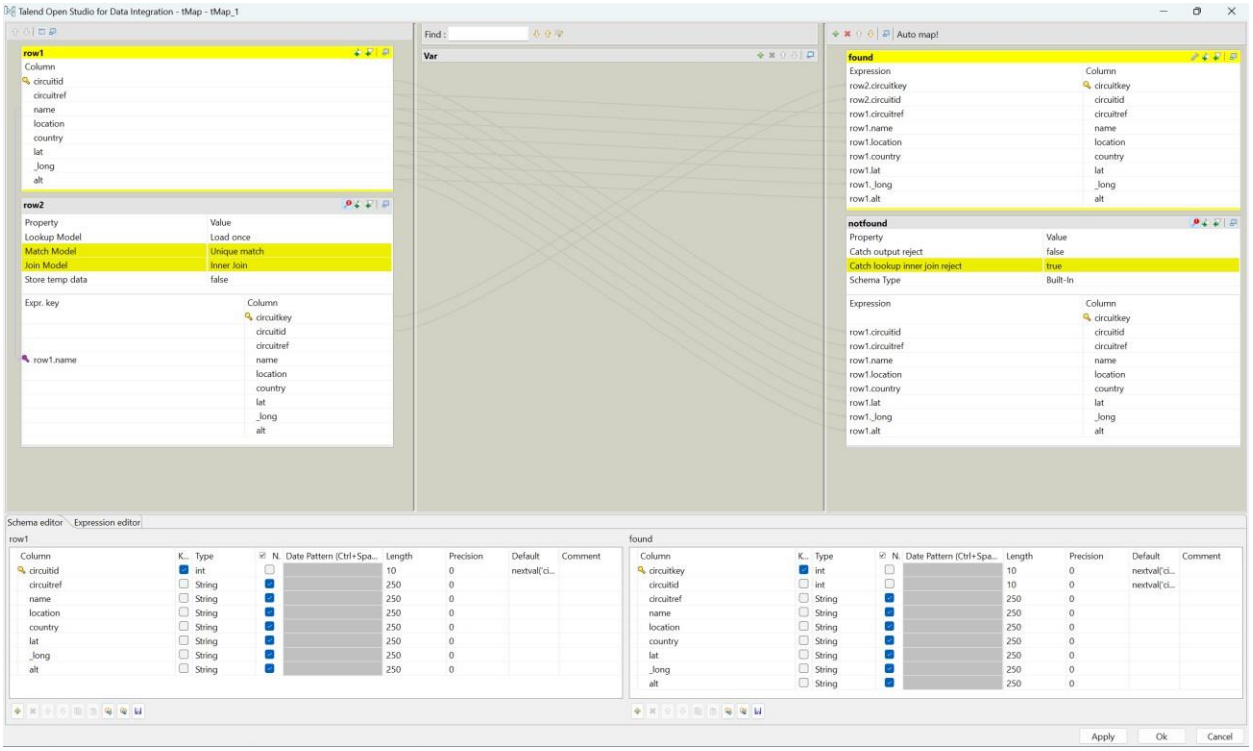
7. Select the first qualifying driver in race Australian Grand Prix

   OUTPUT 7 ← DICE (F1, race.name = ‘Australian Grand Prix’)
   OUTPUT ← ROLLUP* (OUTPUT 7, Qualifying → Qualifying, MIN(q1) ASfirst_qualifier)

Talend Implementation control and data flows

1. Circuits Dimension





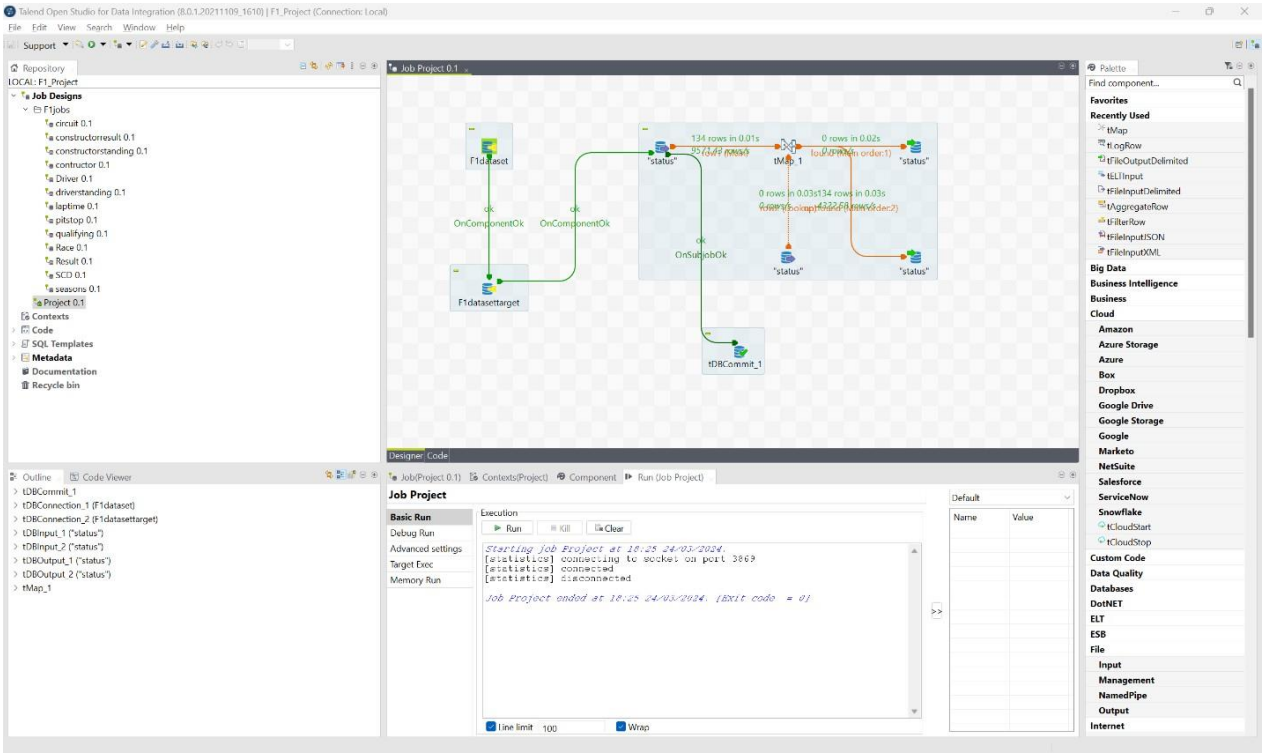
Circuits Dimension Output

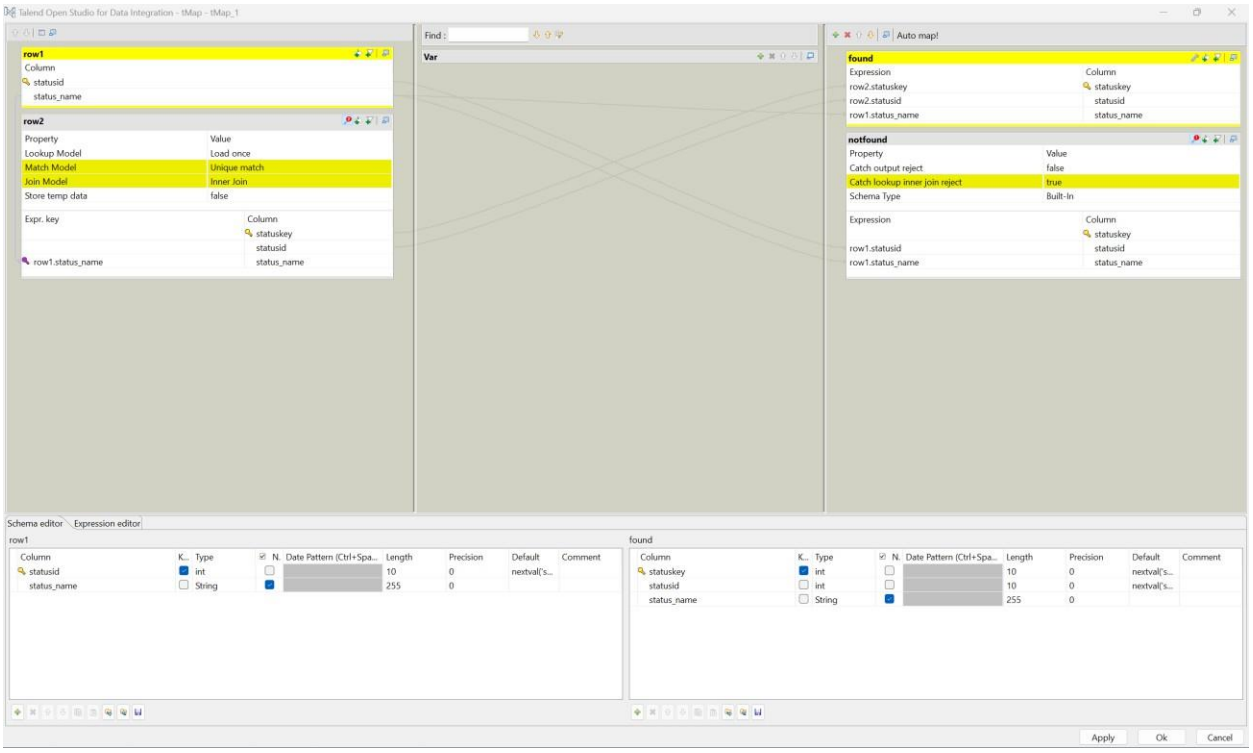
Data Output | Messages | Notifications

	circuitkey [PK] integer	circuitid integer	circuitref character varying (250)	name character varying (250)	location character varying (250)	country character varying (250)	lat character varying (250)	long chara
1	1	1	albert_park	Albert Park Grand Prix Circuit	Melbourne	Australia	-37.8497	144.9
2	2	2	sepang	Sepang International Circuit	Kuala Lumpur	Malaysia	2.76083	101.7
3	3	3	bahrain	Bahrain International Circuit	Sakhir	Bahrain	26.0325	50.51
4	4	4	catalunya	Circuit de Barcelona-Catalunya	Montmel	Spain	41.57	2.261
5	5	5	istanbul	Istanbul Park	Istanbul	Turkey	40.9517	29.40
6	6	6	monaco	Circuit de Monaco	MonteCarlo	Monaco	43.7347	7.420
7	7	7	villeneuve	Circuit Gilles Villeneuve	Montreal	Canada	45.5	-73.5
8	8	8	magny_cours	Circuit de Nevers Magny-Cours	Magny Cours	France	46.8642	3.163
9	9	9	silverstone	Silverstone Circuit	Silverstone	UK	52.0786	-1.01
10	10	10	hockenheimring	Hockenheimring	Hockenheim	Germany	49.3278	8.565
11	11	11	hungaroring	Hungaroring	Budapest	Hungary	47.5789	19.24
12	12	12	valencia	Valencia Street Circuit	Valencia	Spain	39.4589	-0.33

Total rows: 73 of 73 | Query complete 00:00:00.122 | Ln 1, Col 23

2. Status Dimension





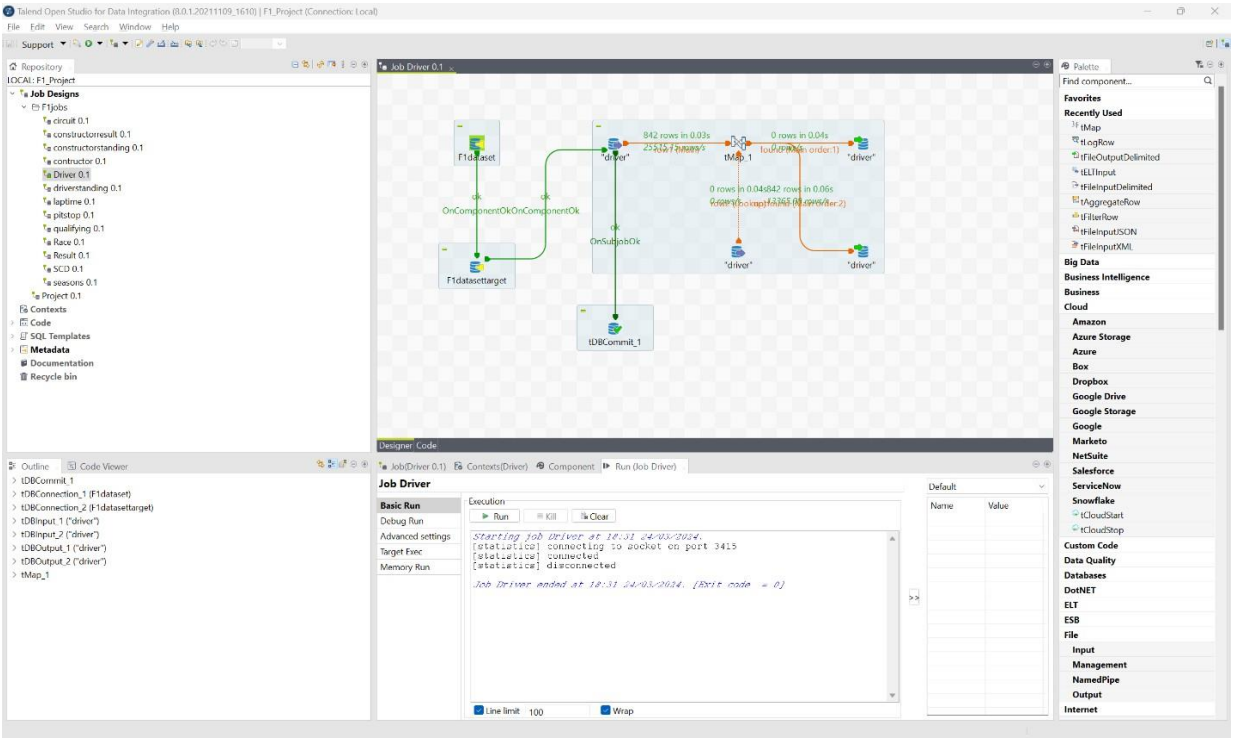
Status Dimension Output

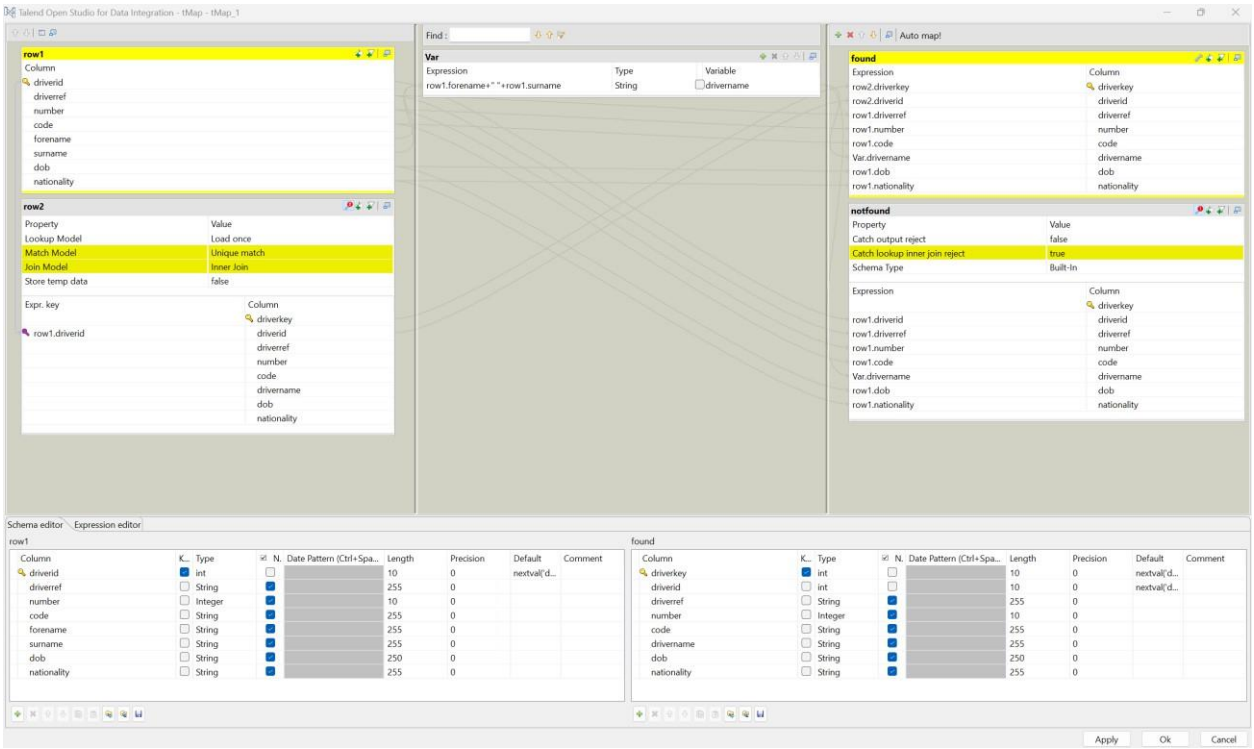
Data Output | Messages | Notifications

	statuskey [PK] integer	statusid integer	status_name character varying (255)
1	1	1	Finished
2	2	2	Disqualified
3	3	3	Accident
4	4	4	Collision
5	5	5	Engine
6	6	6	Gearbox
7	7	7	Transmission
8	8	8	Clutch
9	9	9	Hydraulics
10	10	10	Electrical
11	11	11	+1 Lap
12	12	12	+2 Laps

Total rows: 134 of 134 | Query complete 00:00:00.149 | Ln 1, Col 21

3. Driver Dimension





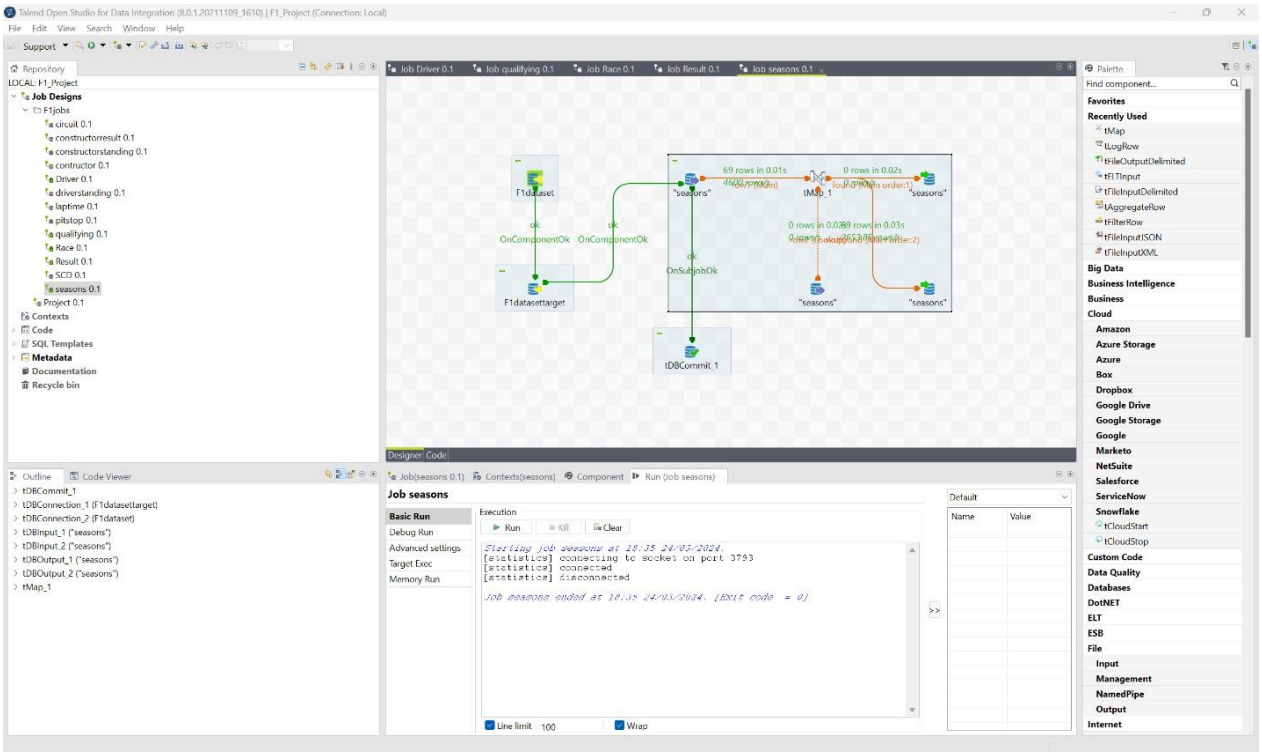
Driver Dimension Output

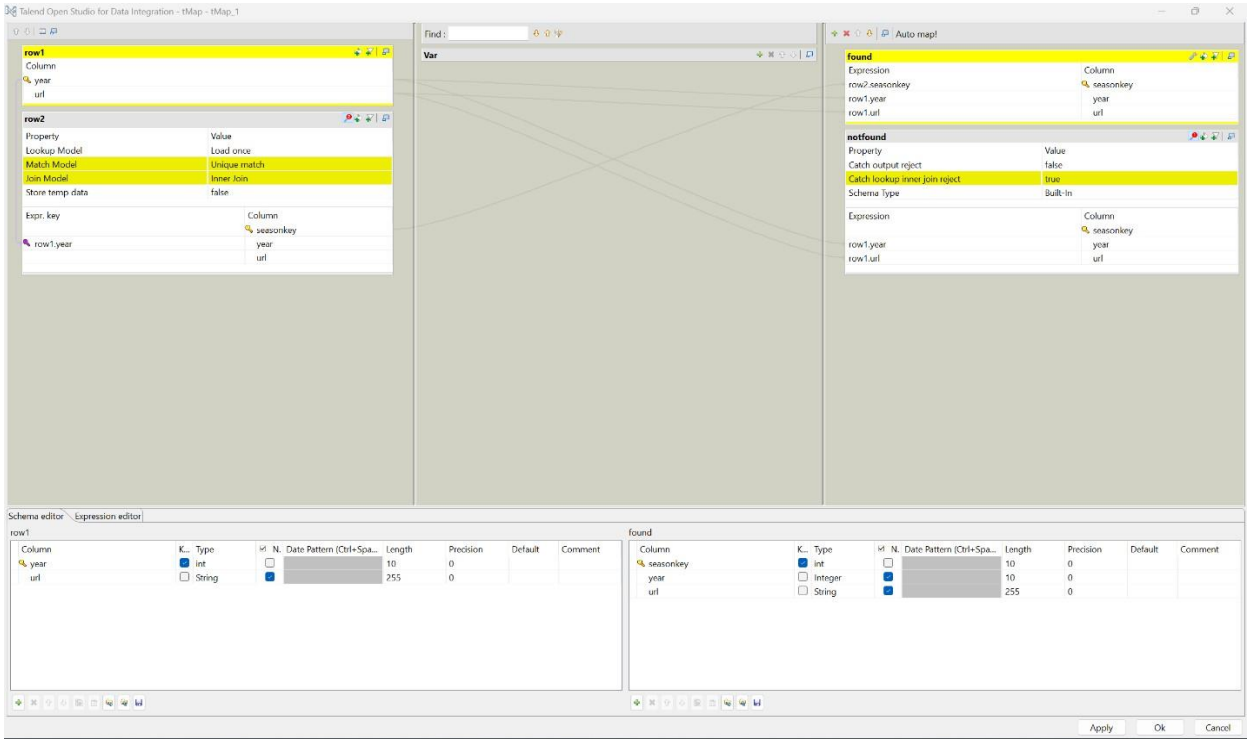
Data Output | Messages | Notifications

	driverkey [PK] integer	driverid integer	driverref character varying (255)	number integer	code character varying (255)	drivername character varying (255)	dob character varying (250)	nationality character varying (255)
1	1	1	hamilton	44	HAM	Lewis Hamilton	7/1/1985	British
2	2	2	heidfeld	[null]	HEI	Nick Heidfeld	10/5/1977	German
3	3	3	rosberg	6	ROS	Nico Rosberg	27/06/1985	German
4	4	4	alonso	14	ALO	Fernando Alonso	29/07/1981	Spanish
5	5	5	kovalainen	[null]	KOV	Heikki Kovalainen	19/10/1981	Finnish
6	6	6	nakajima	[null]	NAK	Kazuki Nakajima	11/1/1985	Japanese
7	7	7	bourdais	[null]	BOU	Sicbastien Bourdais	28/02/1979	French
8	8	8	raikkonen	7	RAI	Kimi Rnen	17/10/1979	Finnish
9	9	9	kubica	[null]	KUB	Robert Kubica	7/12/1984	Polish
10	10	10	glock	[null]	GLO	Timo Glock	18/03/1982	German
11	11	11	sato	[null]	SAT	Takuma Sato	28/01/1977	Japanese
12	12	12	piquet_jr	[null]	PIQ	Nelson Piquet Jr	25/07/1985	Brazilian

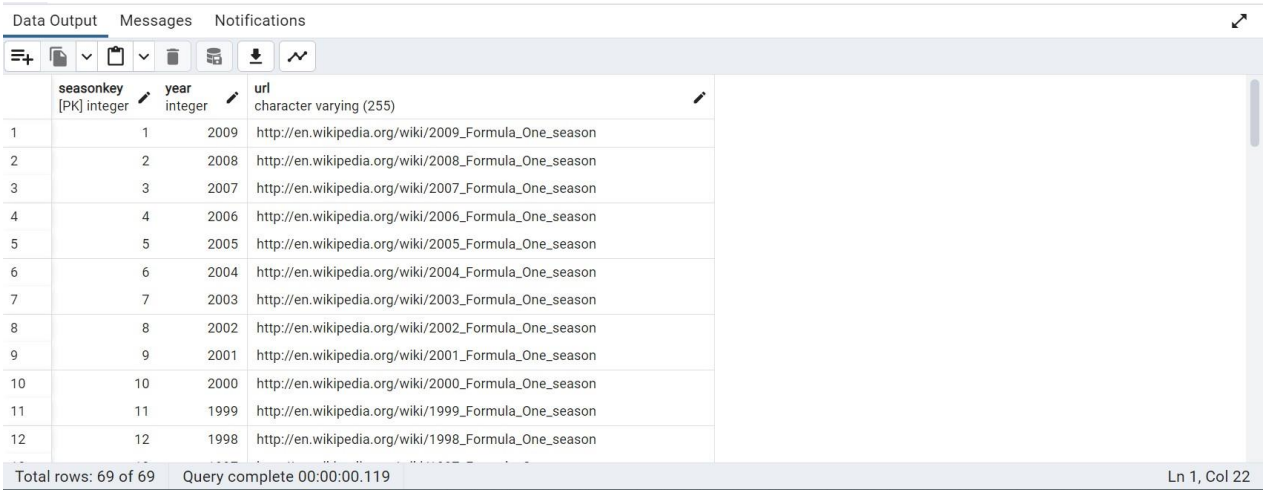
Total rows: 842 of 842 | Query complete 00:00:00.151 | Ln 1, Col 21

4. Seasons Dimension

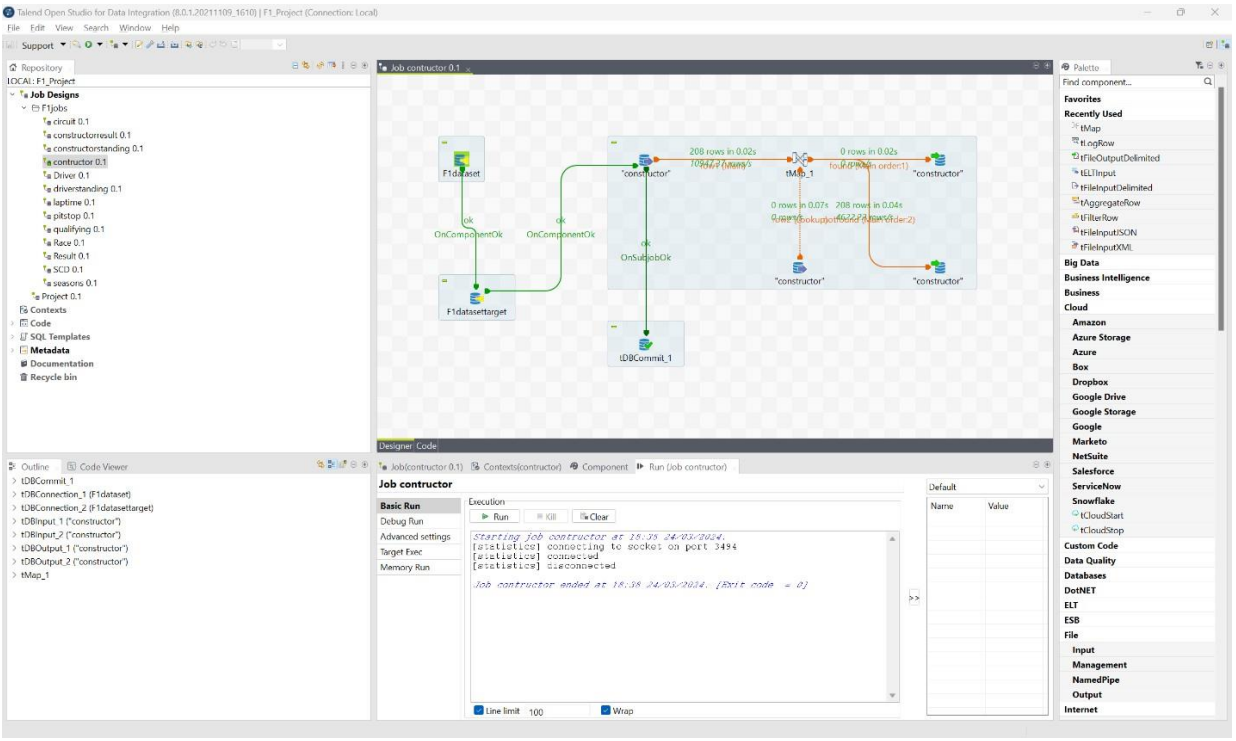


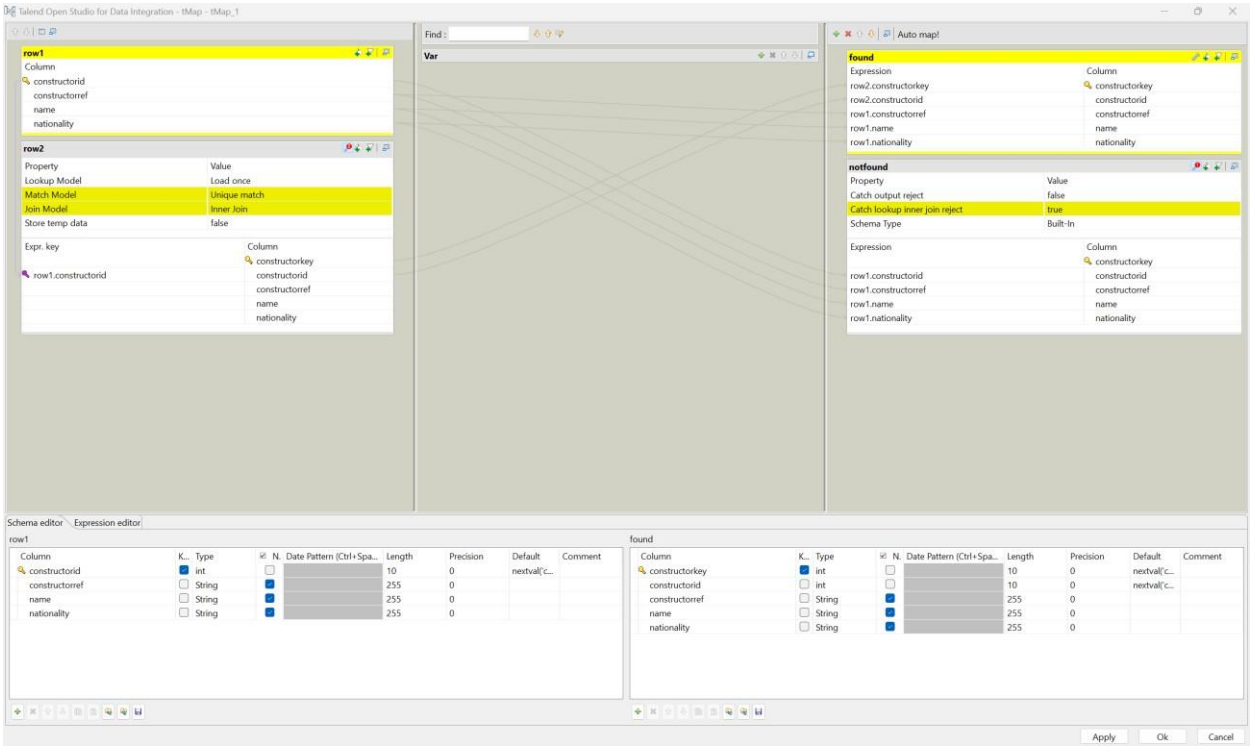


Season Dimension Output



5. Constructor Dimension





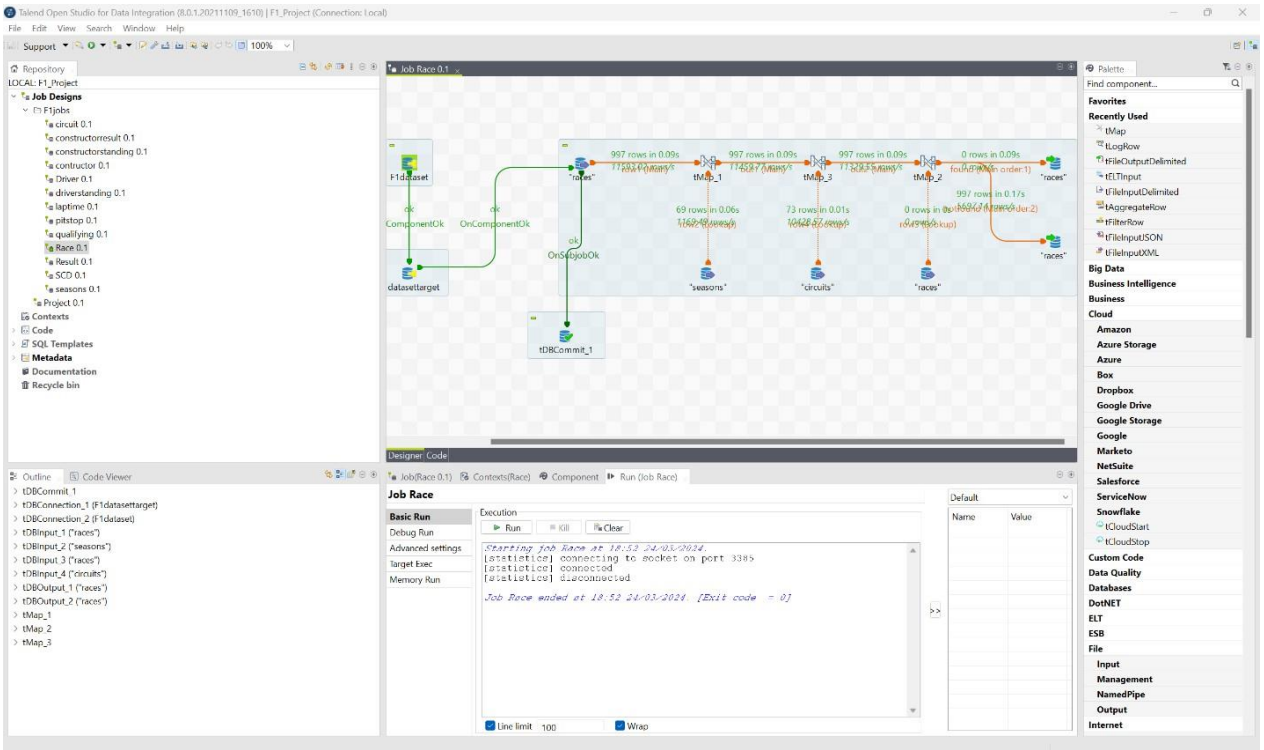
Constructor Dimension Output

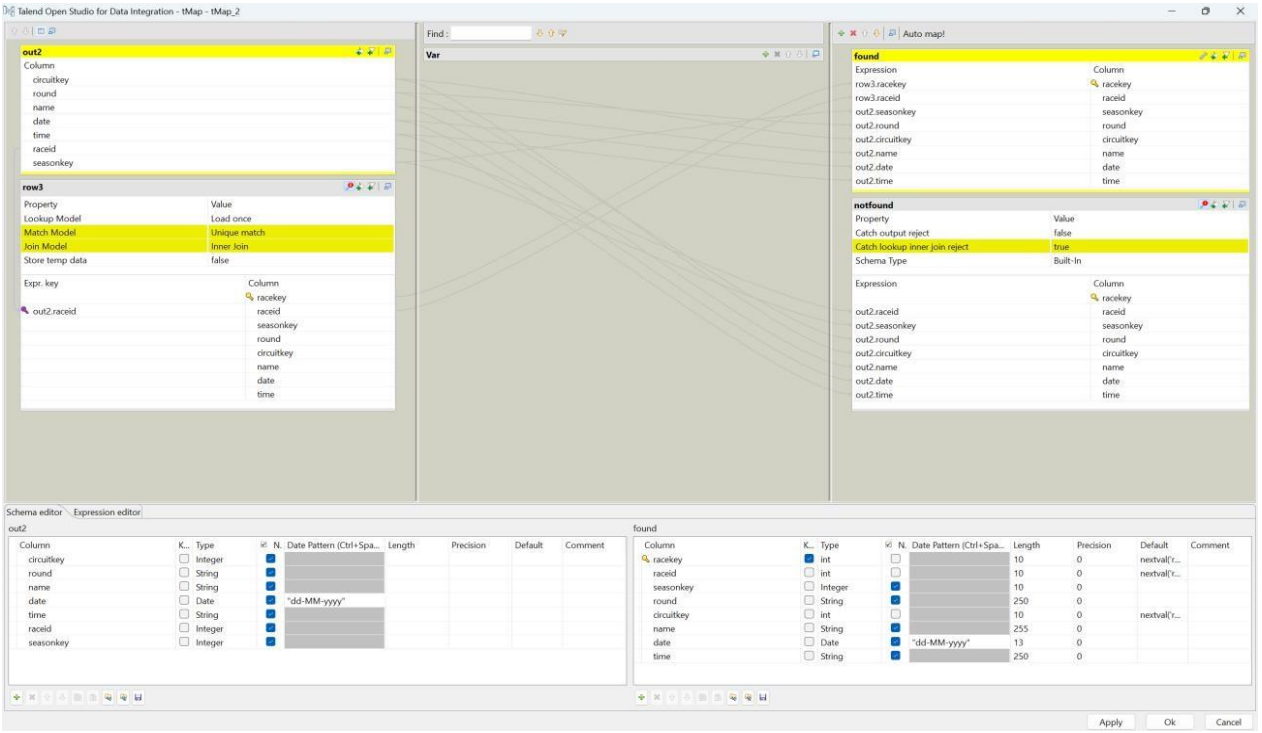
Data Output | Messages | Notifications

	constructorkey [PK] integer	constructorid integer	constructorref character varying (255)	name character varying (255)	nationality character varying (255)
1	1	1	mclaren	McLaren	British
2	2	2	bmw_sauber	BMW Sauber	German
3	3	3	williams	Williams	British
4	4	4	renault	Renault	French
5	5	5	toro_rosso	Toro Rosso	Italian
6	6	6	ferrari	Ferrari	Italian
7	7	7	toyota	Toyota	Japanese
8	8	8	super_aguri	Super Aguri	Japanese
9	9	9	red_bull	Red Bull	Austrian
10	10	10	force_india	Force India	Indian
11	11	11	honda	Honda	Japanese
12	12	12	spyker	Spyker	Dutch

Total rows: 208 of 208 | Query complete 00:00:00.120 | Ln 1, Col 26

6. Races Dimension





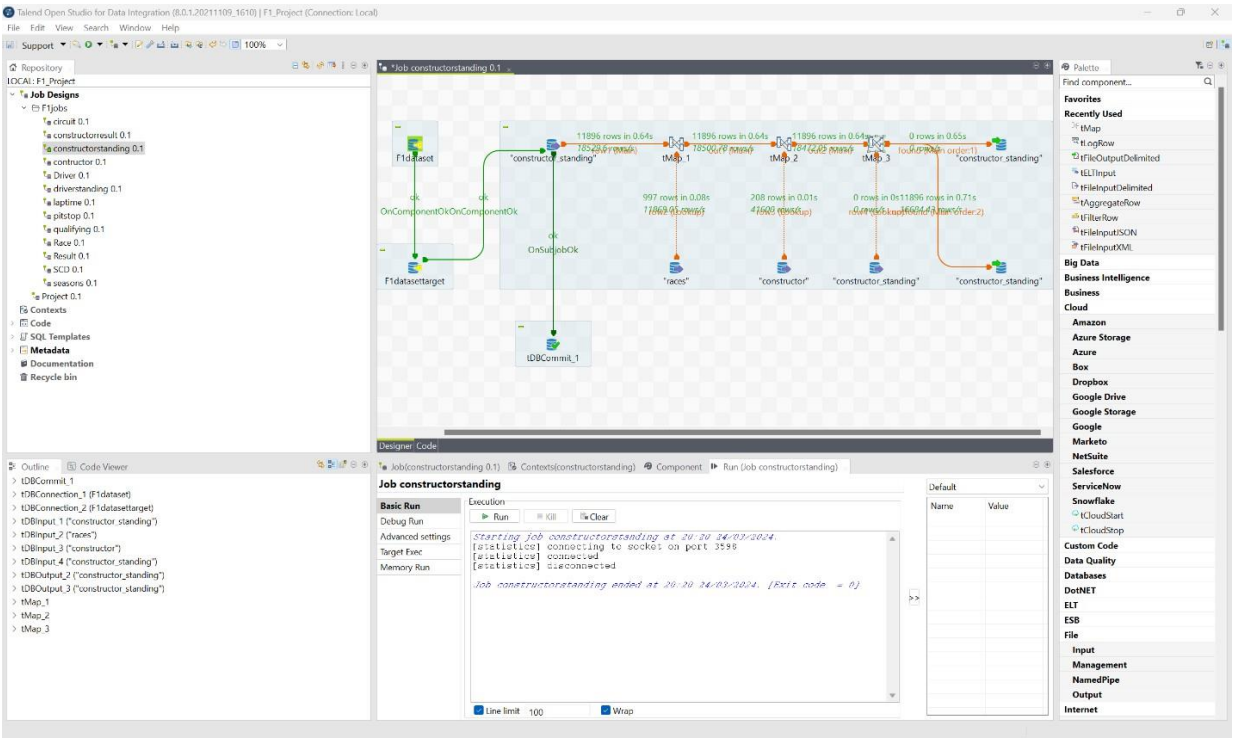
Races Dimension Output

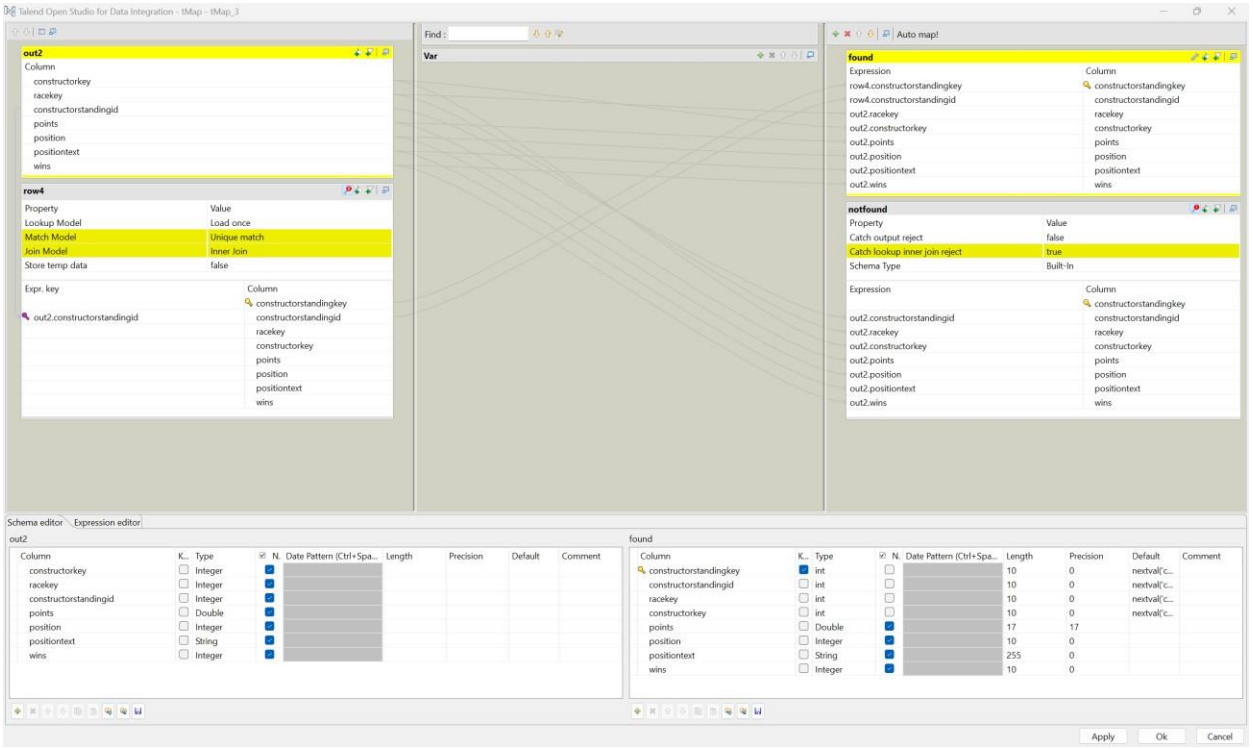
Data Output | Messages | Notifications

	racekey [PK] integer	raceid integer	seasonkey integer	round character varying (250)	circuitkey integer	name character varying (255)	date date	time character varying (250)
1	1	1	1	1	1	Australian Grand Prix	2009-03-29	6:00:00
2	2	2	1	2	2	Malaysian Grand Prix	2009-04-05	9:00:00
3	3	3	1	3	17	Chinese Grand Prix	2009-04-19	7:00:00
4	4	4	1	4	3	Bahrain Grand Prix	2009-04-26	12:00:00
5	5	5	1	5	4	Spanish Grand Prix	2009-05-10	12:00:00
6	6	6	1	6	6	Monaco Grand Prix	2009-05-24	12:00:00
7	7	7	1	7	5	Turkish Grand Prix	2009-06-07	12:00:00
8	8	8	1	8	9	British Grand Prix	2009-06-21	12:00:00
9	9	9	1	9	20	German Grand Prix	2009-07-12	12:00:00
10	10	10	1	10	11	Hungarian Grand Prix	2009-07-26	12:00:00
11	11	11	1	11	12	European Grand Prix	2009-08-23	12:00:00
12	12	12	1	12	13	Belgian Grand Prix	2009-08-30	12:00:00

Total rows: 997 of 997 | Query complete 00:00:00.216 | Ln 1, Col 20

7. Constructor Standing Dimension





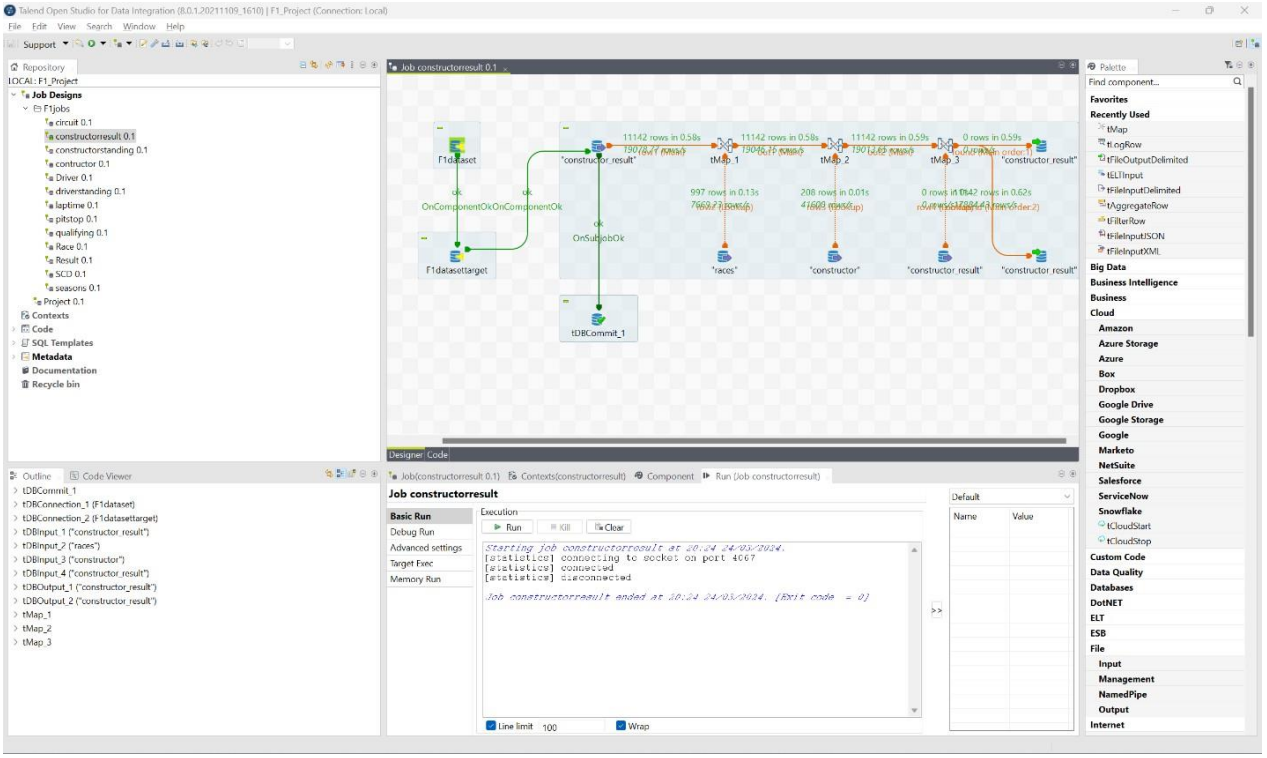
Constructor Standing Dimension Output

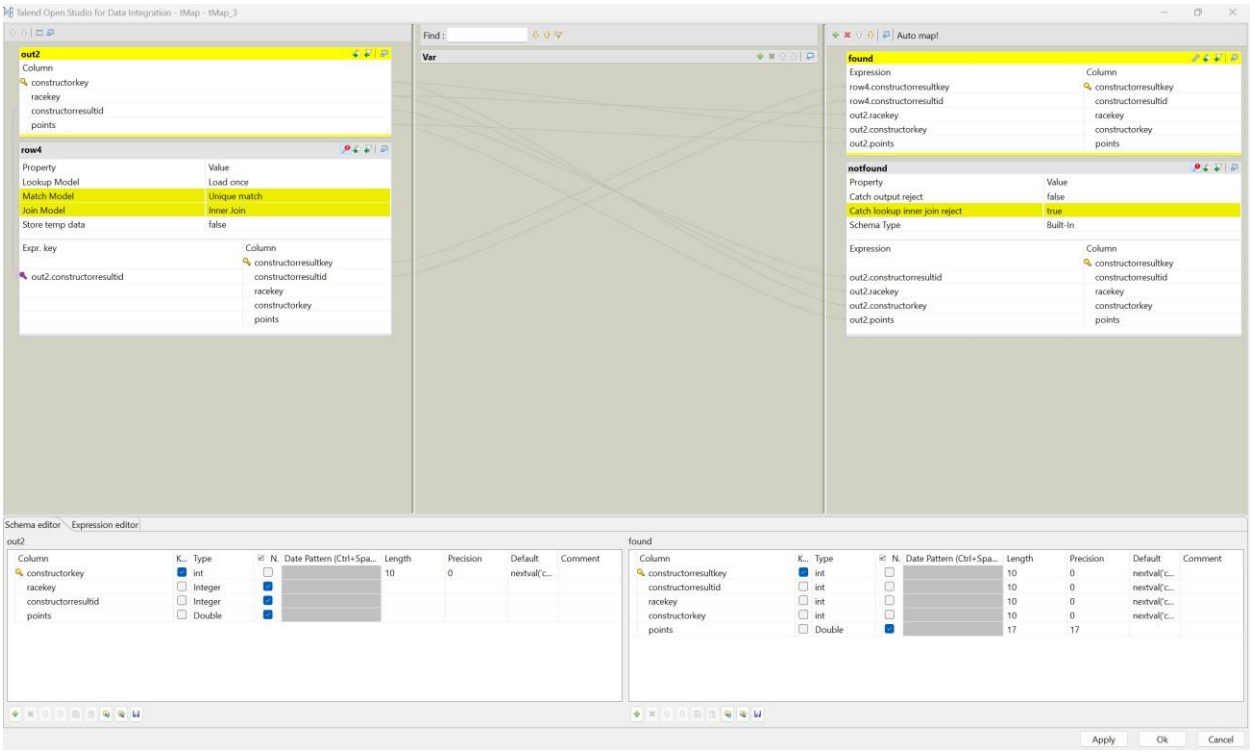
Data Output | Messages | Notifications

	constructorstandingkey [PK] integer	constructorstandingid integer	racekey integer	constructorkey integer	points double precision	position integer	positiontext character varying (255)	wins integer
1	1	1	18	1	14	1	1	1
2	2	2	18	2	8	3	3	0
3	3	3	18	3	9	2	2	0
4	4	4	18	4	5	4	4	0
5	5	5	18	5	2	5	5	0
6	6	6	18	6	1	6	6	0
7	7	7	19	1	24	1	1	1
8	8	8	19	2	19	2	2	0
9	9	9	19	3	9	4	4	0
10	10	10	19	4	6	5	5	0
11	11	11	19	5	2	8	8	0
12	12	12	19	6	11	3	3	1

Total rows: 1000 of 11896 | Query complete 00:00:00.155 | Ln 1, Col 35

8. Constructor Result Dimension





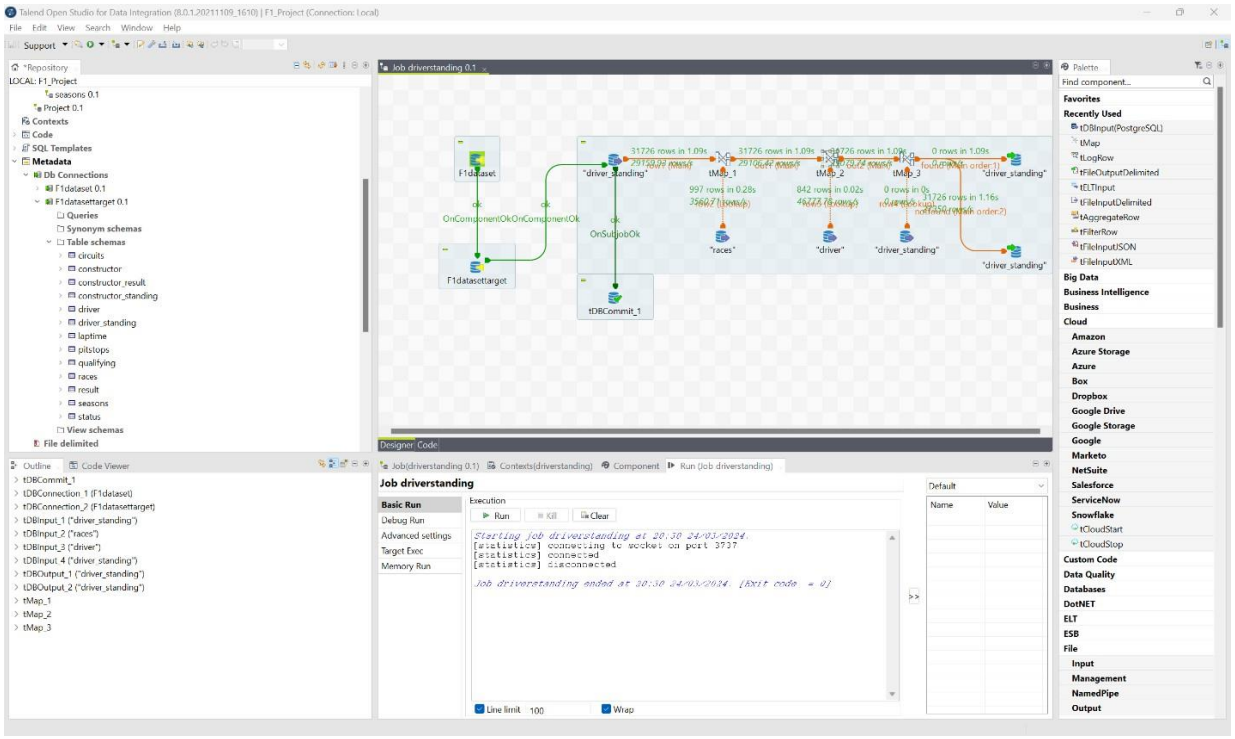
Constructor Result Dimension Output

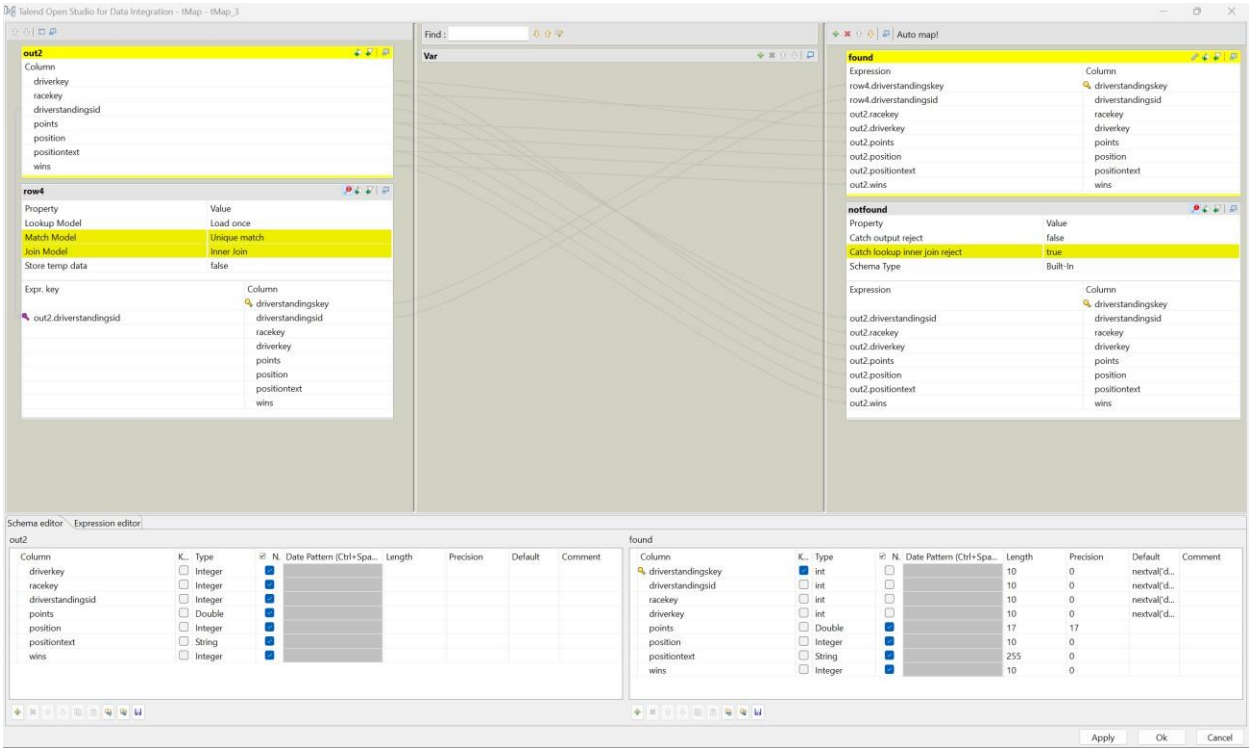
Data Output | Messages | Notifications

	constructorresultkey [PK] integer	constructorresultid integer	racekey integer	constructorkey integer	points double precision
1	1	1	18	1	14
2	2	2	18	2	8
3	3	3	18	3	9
4	4	4	18	4	5
5	5	5	18	5	2
6	6	6	18	6	1
7	7	7	18	7	0
8	8	8	18	8	0
9	9	9	18	9	0
10	10	10	18	10	0
11	11	11	18	11	0
12	12	12	19	6	10

Total rows: 1000 of 11142 | Query complete 00:00:00.142 | Ln 1, Col 33

9. Driver Standing Dimension





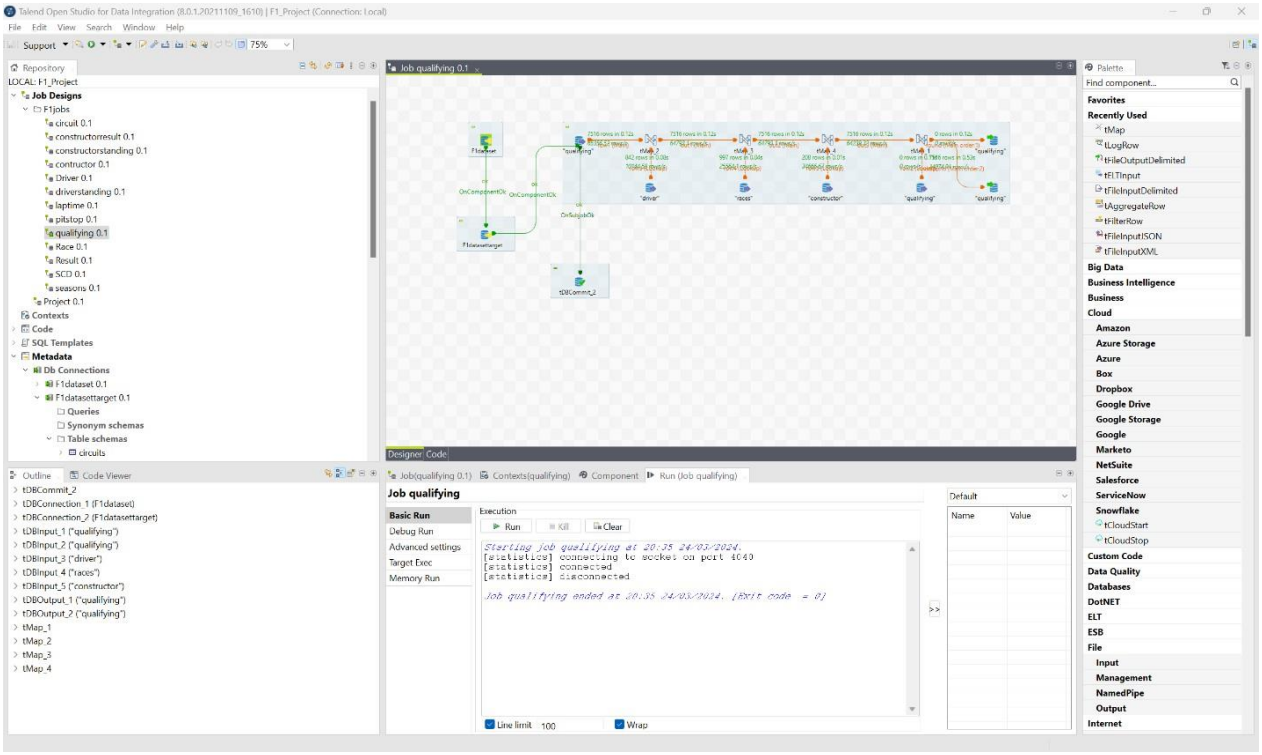
Driver Standing Dimension Output

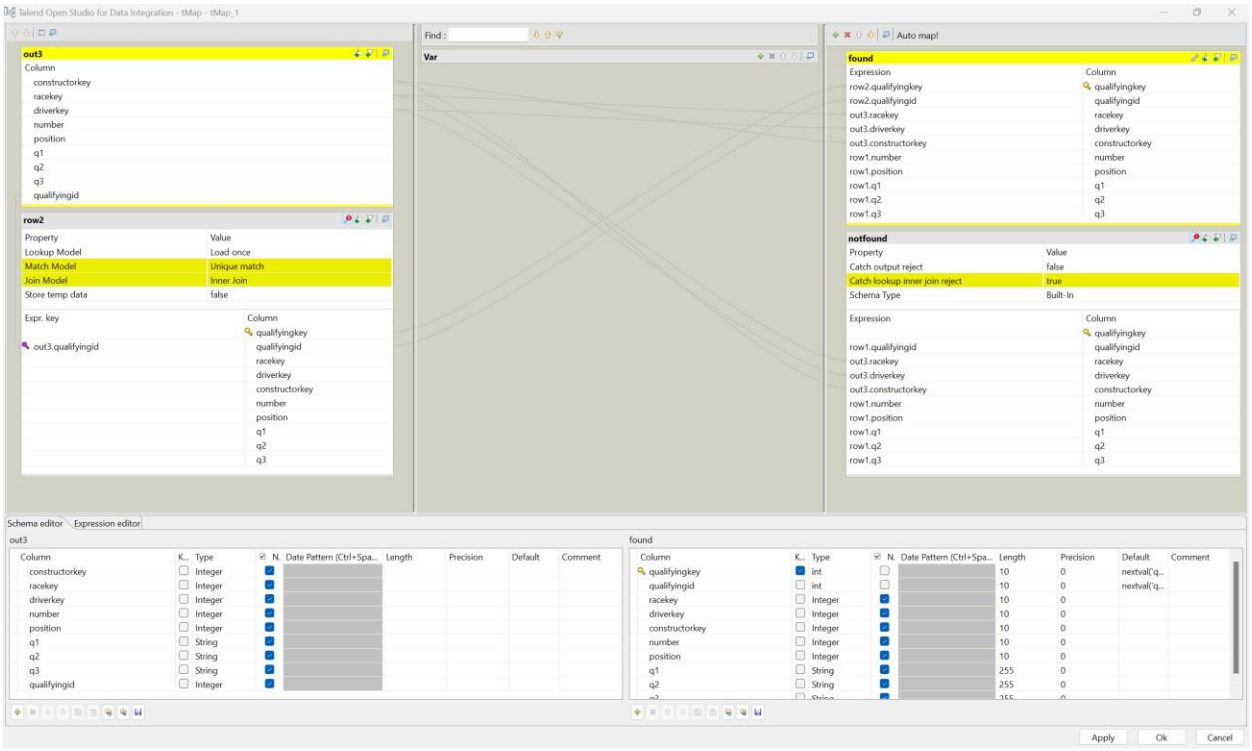
Data Output | Messages | Notifications

	driverstandingskey [PK] integer	driverstandingsid integer	racekey integer	driverkey integer	points double precision	position integer	positiontext character varying (255)	wins integer
1	1	1	18	1	10	1	1	1
2	2	2	18	2	8	2	2	0
3	3	3	18	3	6	3	3	0
4	4	4	18	4	5	4	4	0
5	5	5	18	5	4	5	5	0
6	6	6	18	6	3	6	6	0
7	7	7	18	7	2	7	7	0
8	8	8	18	8	1	8	8	0
9	9	9	19	1	14	1	1	1
10	10	10	19	2	11	3	3	0
11	11	11	19	3	6	6	6	0
12	12	12	19	4	6	7	7	0

Total rows: 1000 of 31726 | Query complete 00:00:00.199 | Ln 1, Col 30

10. Qualifying Dimension





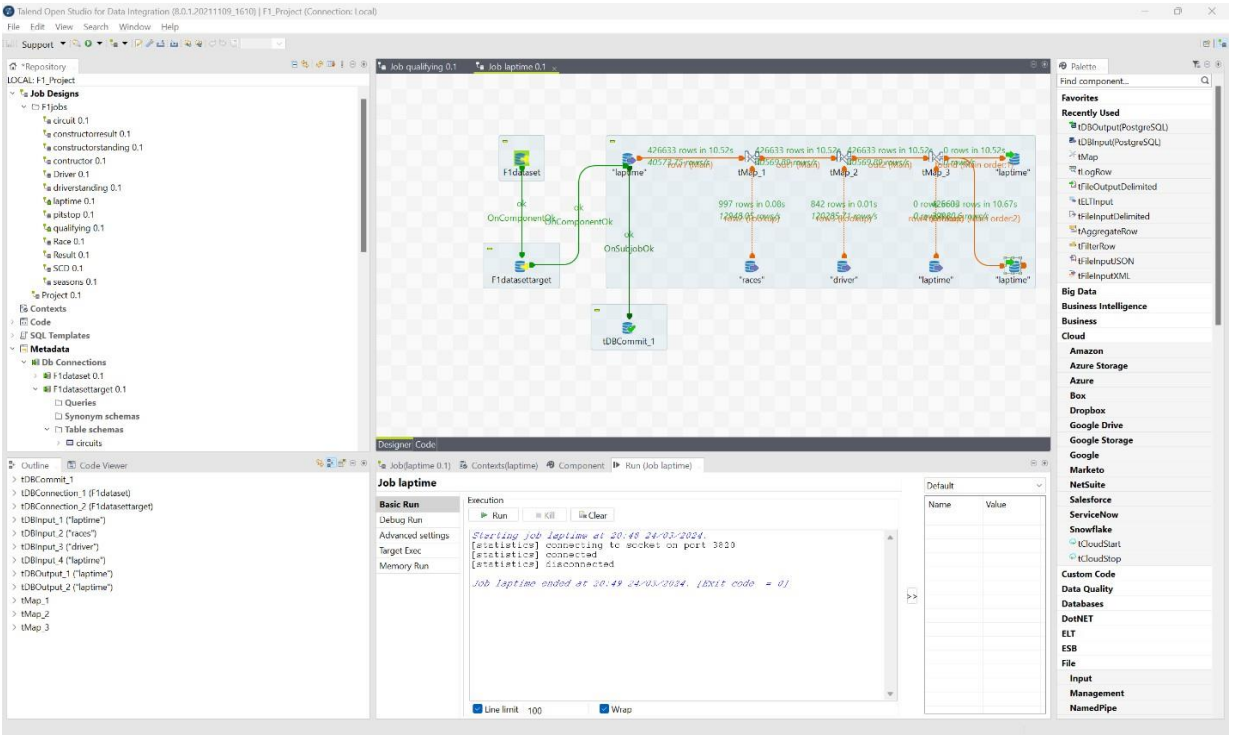
Qualifying Dimension Output

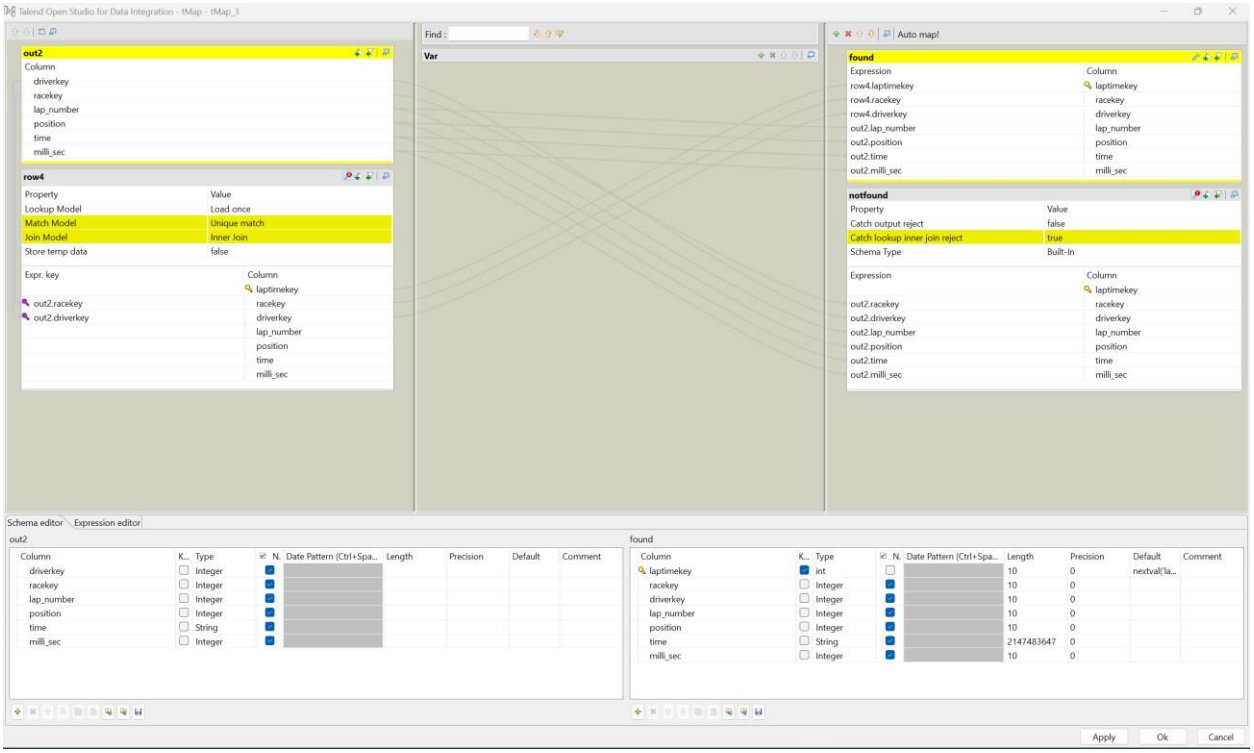
Data Output | Messages | Notifications

	qualifyingkey [PK] integer	qualifyingid integer	racekey integer	driverkey integer	constructorkey integer	number integer	position integer	q1 character varying (255)	q2 character varying (255)	q3 character varying (25
1	1	1	18	1	1	22	1	01:26.6	01:25.2	01:26.7
2	2	2	18	9	2	4	2	01:26.1	01:25.3	01:26.9
3	3	3	18	5	1	23	3	01:25.7	01:25.5	01:27.1
4	4	4	18	13	6	2	4	01:26.0	01:25.7	01:27.2
5	5	5	18	2	2	3	5	01:26.0	01:25.5	01:27.2
6	6	6	18	15	7	11	6	01:26.4	01:26.1	01:28.5
7	7	7	18	3	3	7	7	01:26.3	01:26.1	01:28.7
8	8	8	18	14	9	9	8	01:26.4	01:26.1	01:29.0
9	9	9	18	10	7	12	9	01:26.9	01:26.2	01:29.6
10	10	10	18	20	5	15	10	01:26.7	01:25.8	[null]
11	11	11	18	22	11	17	11	01:26.4	01:26.2	[null]
12	12	12	18	4	4	5	12	01:26.9	01:26.2	[null]

Total rows: 1000 of 7516 | Query complete 00:00:00.180 | Ln 1, Col 25

11. Lap time Dimension





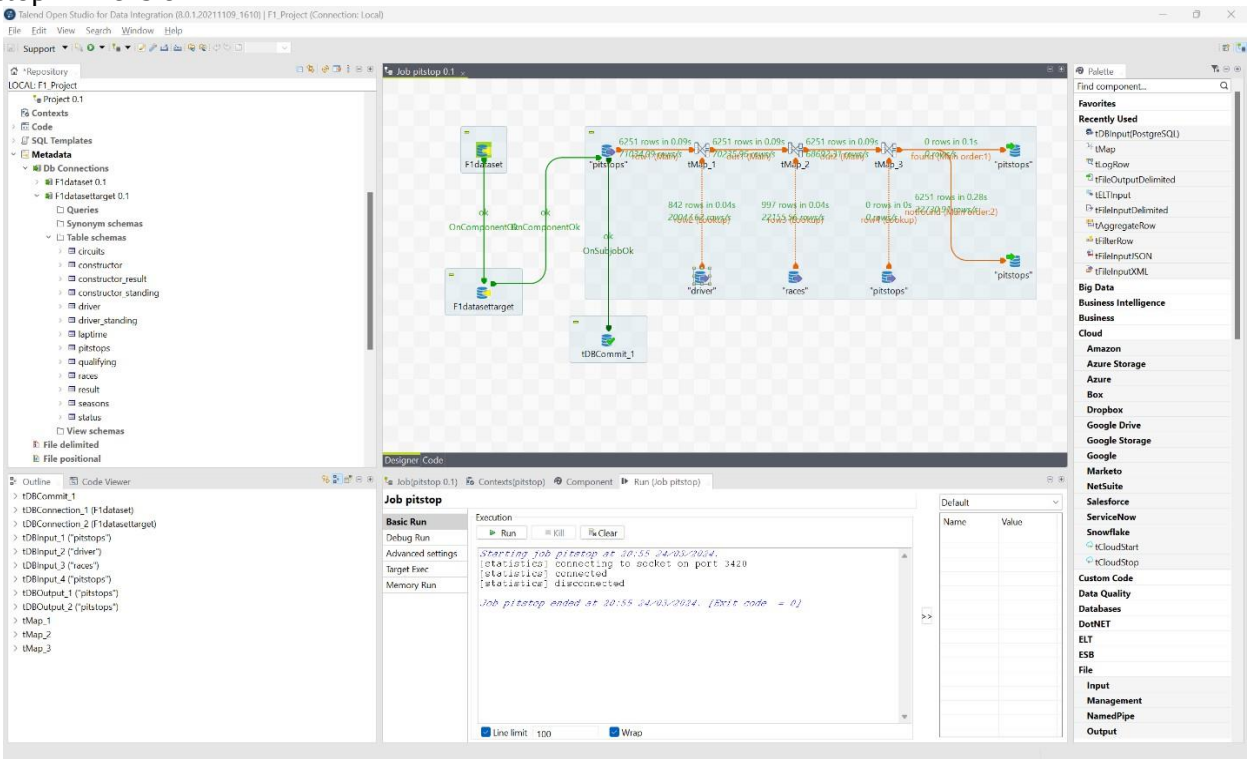
Lap time Dimension Output

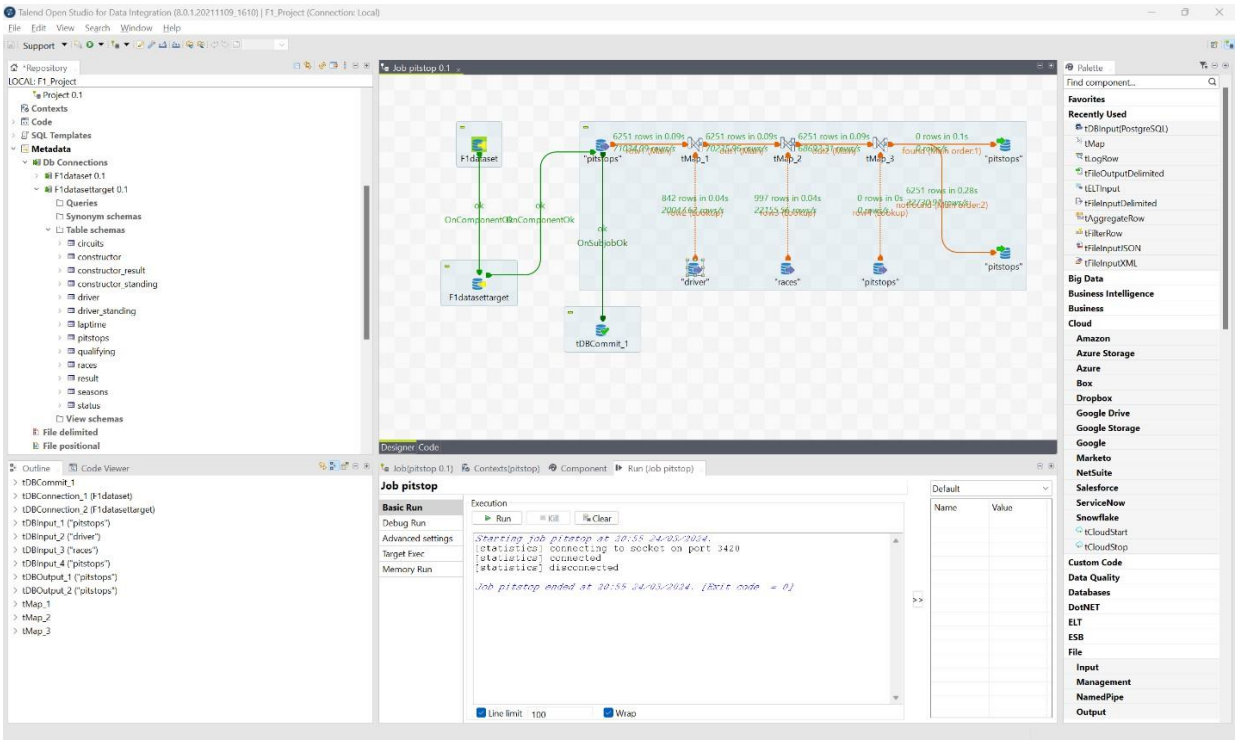
Data Output | Messages | Notifications

	laptimekey [PK] integer	racekey integer	driverkey integer	lap_number integer	position integer	time character varying	milli_sec integer
1	1	840	20	1	1	1:38.109	98109
2	2	840	20	2	1	1:33.006	93006
3	3	840	20	3	1	1:32.713	92713
4	4	840	20	4	1	1:32.803	92803
5	5	840	20	5	1	1:32.342	92342
6	6	840	20	6	1	1:32.605	92605
7	7	840	20	7	1	1:32.502	92502
8	8	840	20	8	1	1:32.537	92537
9	9	840	20	9	1	1:33.240	93240
10	10	840	20	10	1	1:32.572	92572
11	11	840	20	11	1	1:32.669	92669
12	12	840	20	12	1	1:32.902	92902

Total rows: 1000 of 426633 | Query complete 00:00:00.590 | Ln 1, Col 22

12. Pitstop Dimension





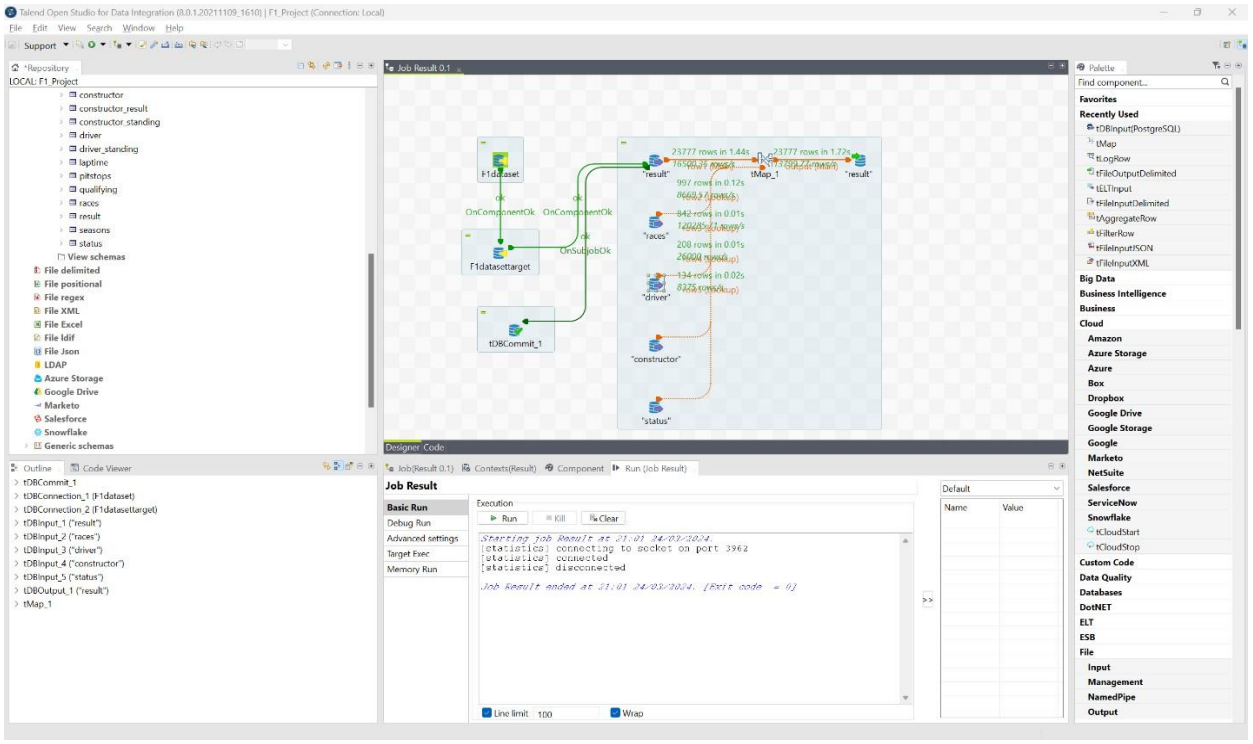
Pitstop Dimension Output

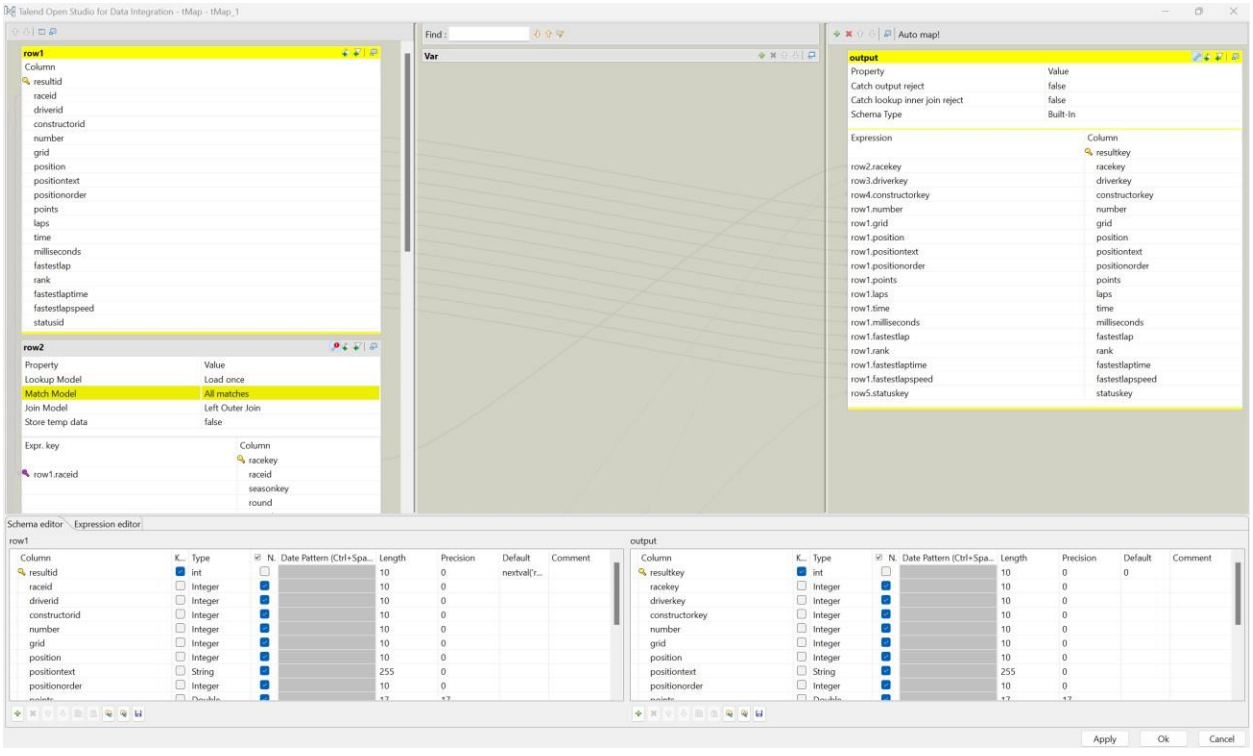
Data Output | Messages | Notifications

	pitstopkey [PK] integer	racekey integer	driverkey integer	stop integer	lap_number integer	time character varying (250)	milli_sec integer
1	1	840	153	1	1	17:05:23	26898
2	2	840	30	1	1	17:05:52	25021
3	3	840	17	1	11	17:20:48	23426
4	4	840	4	1	12	17:22:34	23251
5	5	840	13	1	13	17:24:10	23842
6	6	840	22	1	13	17:24:29	23643
7	7	840	20	1	14	17:25:17	22603
8	8	840	814	1	14	17:26:03	24863
9	9	840	816	1	14	17:26:50	25259
10	10	840	67	1	15	17:27:34	25342
11	11	840	2	1	15	17:27:41	22994
12	12	840	1	1	16	17:28:24	23227

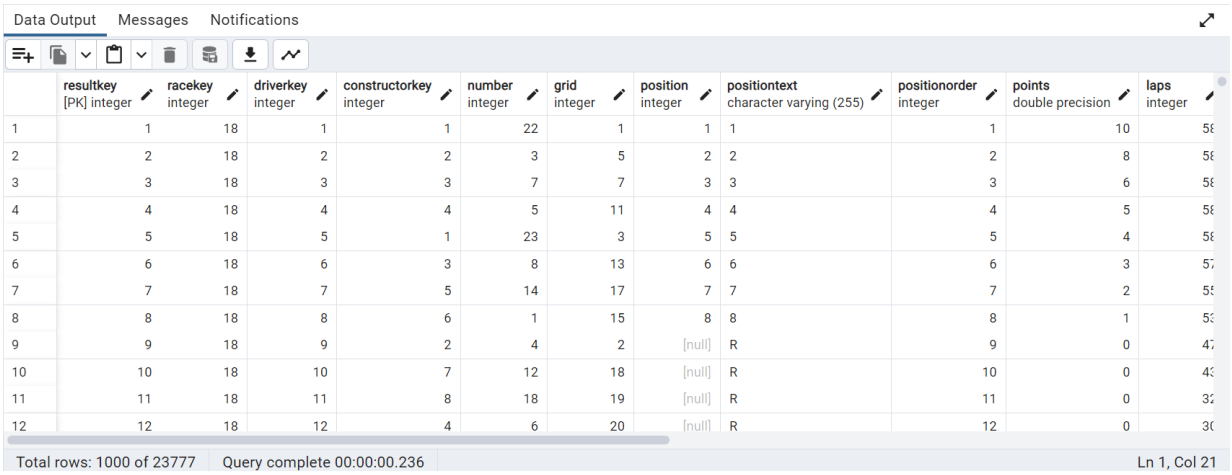
Total rows: 1000 of 6251 | Query complete 00:00:00.152 | Ln 1, Col 23

13. Result Fact Table





Result Fact Table Output

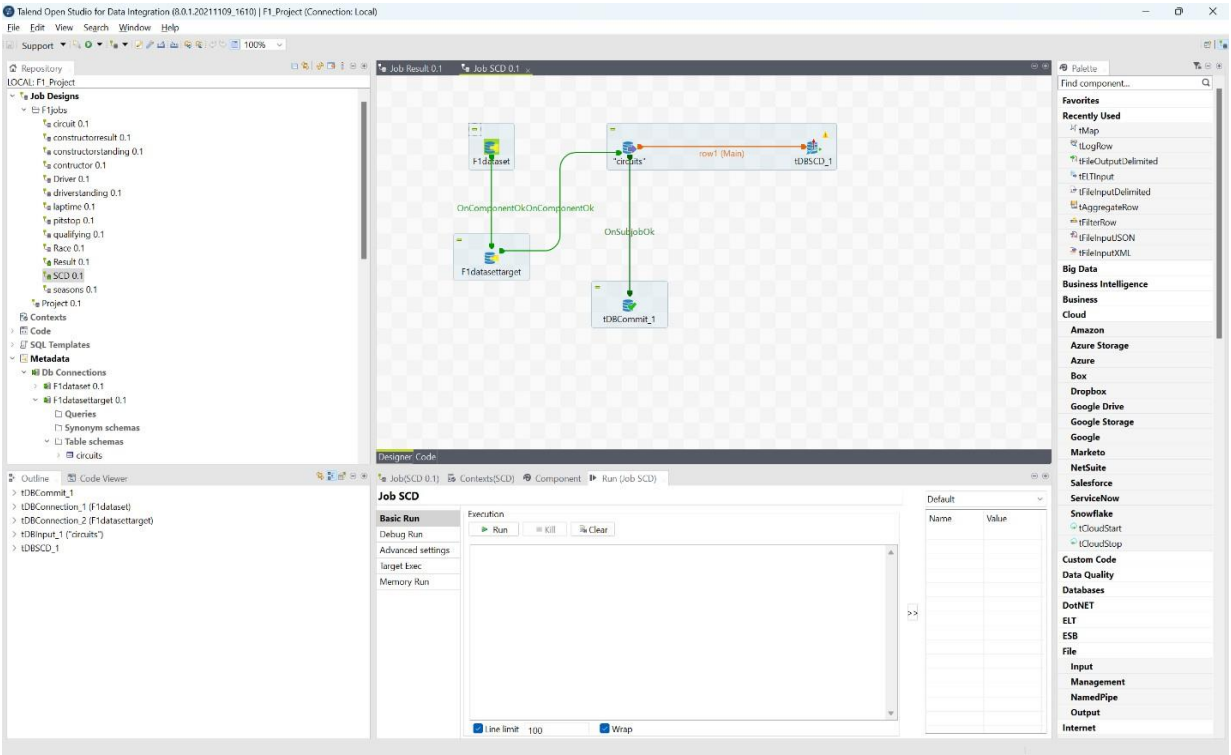


Data Output | Messages | Notifications

	resultkey [PK] integer	racekey integer	driverkey integer	constructorkey integer	number integer	grid integer	position integer	positiontext character varying (255)	positionorder integer	points double precision	laps integer
1	1	18	1	1	22	1	1	1	1	10	58
2	2	18	2	2	3	5	2	2	2	8	58
3	3	18	3	3	7	7	3	3	3	6	58
4	4	18	4	4	5	11	4	4	4	5	58
5	5	18	5	1	23	3	5	5	5	4	58
6	6	18	6	3	8	13	6	6	6	3	57
7	7	18	7	5	14	17	7	7	7	2	55
8	8	18	8	6	1	15	8	8	8	1	53
9	9	18	9	2	4	2	[null]	R	9	0	47
10	10	18	10	7	12	18	[null]	R	10	0	43
11	11	18	11	8	18	19	[null]	R	11	0	32
12	12	18	12	4	6	20	[null]	R	12	0	30

Total rows: 1000 of 23777 | Query complete 00:00:00.236 | Ln 1, Col 21

14. SCD



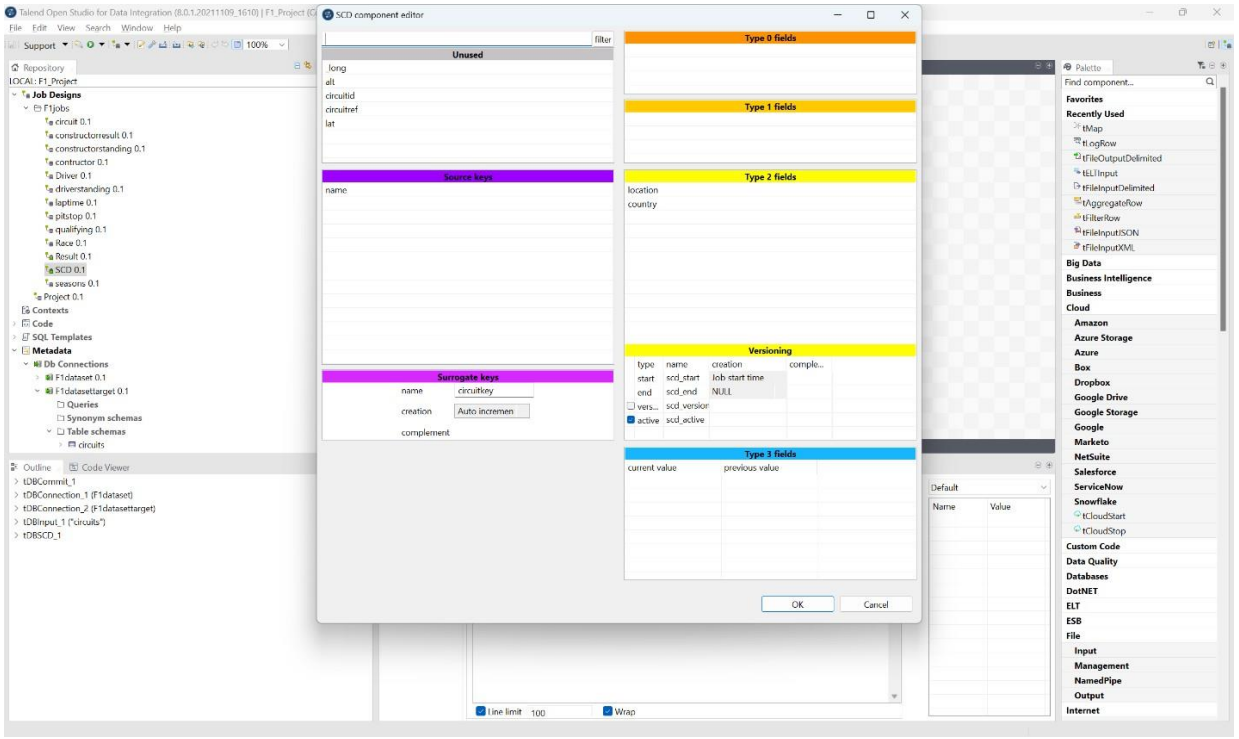
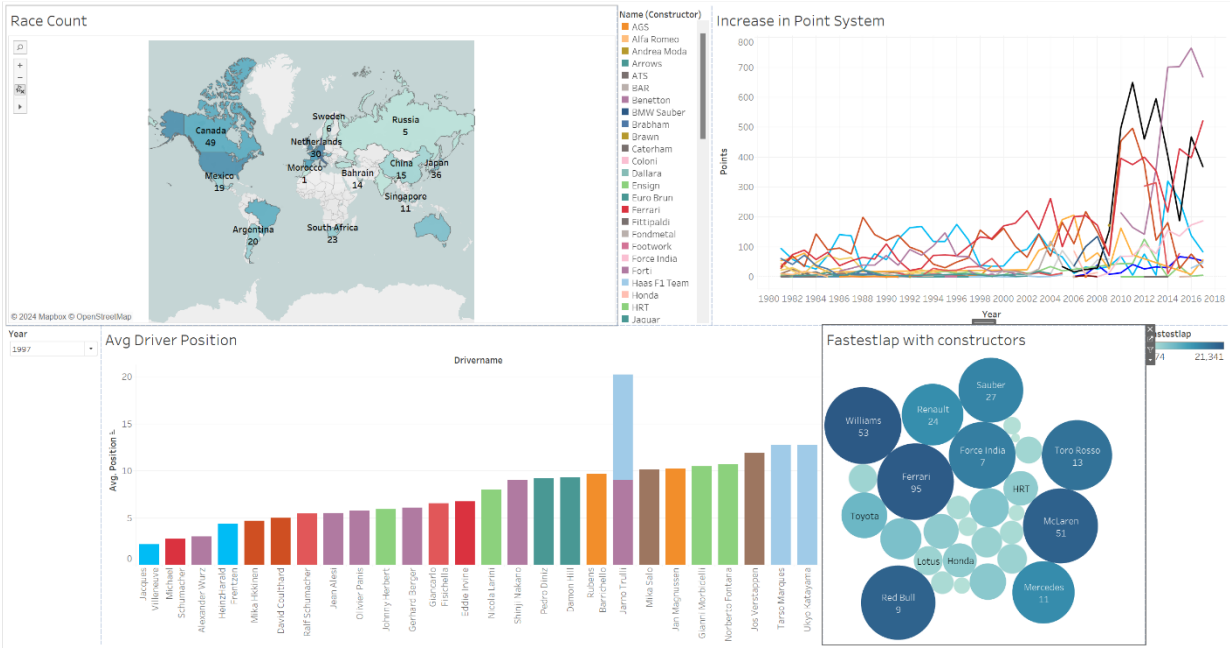


Tableau Dashboard



Airbnb Price Analysis

Project Proposal Summary:

We propose to transform the Boston Airbnb dataset, consisting of 95 columns, into dimension and fact tables. This structured approach will involve grouping related columns into dimension tables such as Listing, Host, Location, Property, Availability, and Review, while aggregating numerical data into a Fact Table capturing pricing details. By implementing this transformation, we aim to streamline data analysis, enhance decision- making processes, and provide valuable insights for Airbnb hosts and guests.

Analysis Objectives:

In addition to structuring the dataset into dimension and fact tables, we aim to conduct in-depth analysis on property listings based on geographical areas, pricing dynamics, and neighbourhood-specific trends. This analysis will involve:

Geographical Analysis:

- Segmenting property listings by geographical areas such as neighbourhoods, cities, and states.
- Analysing the distribution of listings across different areas to identify popular and emerging markets.
- Investigating spatial patterns and correlations between listing characteristics and geographical features.

Price Analysis:

- Studying the pricing variations across different geographical areas and neighbourhoods.
- Identifying factors influencing pricing decisions, such as property type, amenities, and seasonal demand.
- Conducting comparative analysis to determine price competitiveness and value propositions for listings in specific areas.

Neighbourhood Analysis:

- Examining property listings within individual neighbourhoods to understand localized demand and preferences.
- Assessing neighbourhood-specific amenities, attractions, and accessibility factors influencing listing popularity and pricing.
- Utilizing sentiment analysis or reviews data to gauge neighbourhood reputation and guest satisfaction levels.

Extra Charges Analysis:

- Investigating additional charges such as cleaning fees, security deposits, and fees for extra guests.
- Analysing the impact of extra charges on booking patterns, guest satisfaction, and overall listing performance.
- Identifying optimal pricing strategies for extra charges to maximize revenue while maintaining competitiveness.

Here's a description of each dimension and fact table along with their columns that we will make from raw dataset:

1. Listing Dimension Table:

- Listing_id: Unique identifier for each listing.

- Name: Name of the listing.

- Description: Description of the listing.

- Transit: Information about transportation options nearby.

- House_rules: Rules set by the host for guests.

- Interaction: Information about interaction with guests provided by the host.
- Guest_included: Number of guests included in the listing.
- Min_night: Minimum number of nights required for booking.
- Max_night: Maximum number of nights allowed for booking.
- Require_license: Indicates if a license is required for booking.
- Instant_bookable: Indicates if the listing supports instant booking.
- Cancellation_policy: Policy regarding cancellation of bookings.

2. Host Dimension Table:

- Id: Unique identifier for each host.
- Name: Name of the host.
- Host_since: Date when the host joined Airbnb.
- Host_location: Location of the host.
- Host_response_time: Response time of the host to inquiries.
- Host_response_rate: Rate of response by the host.
- Host_total_listings: Total number of listings managed by the host.
- Host_identity_verified: Indicates if the host's identity is verified.

3. Location Dimension Table:

- Street: Street address of the listing.

-Neighbourhood: Neighbourhood where the listing is located.

- City: City where the listing is located.
- State: State where the listing is located.
- Country: Country where the listing is located.
- Latitude: Latitude coordinates of the listing.
- Longitude: Longitude coordinates of the listing.
- Is_location_exact: Indicates if the location is exact.

4. Property Dimension Table:

- Property_type: Type of property (e.g., apartment, house, etc.).
- Room_type: Type of room (e.g., entire home, private room, shared room).
- Accommodates: Maximum number of guests the property can accommodate.
- Bathrooms: Number of bathrooms in the property.
- Bedrooms: Number of bedrooms in the property.
- Beds: Number of beds in the property.
- Amenities: Amenities provided in the property.

5. Availability Dimension Table:

- Availability_30: Number of days the property is available for booking in the next 30 days.
- Availability_60: Number of days the property is available for booking in the next 60 days.
- Availability_90: Number of days the property is available for booking in the next 90 days.
- Availability_365: Number of days the property is available for booking in the next 365 days.
- Calendar_updated: Date when the calendar was last updated.

6. Review Dimension Table:

- Number_of_reviews: Number of reviews received for the listing.
- Review_score_rating: Overall rating score given by guests.
- Cleanliness_score: Score given for cleanliness.
- Checking_score: Score given for the check-in process.
- Communication_score: Score given for communication with the host.
- Location_score: Score given for the location of the listing.
- Value_score: Score given for the value provided by the listing.

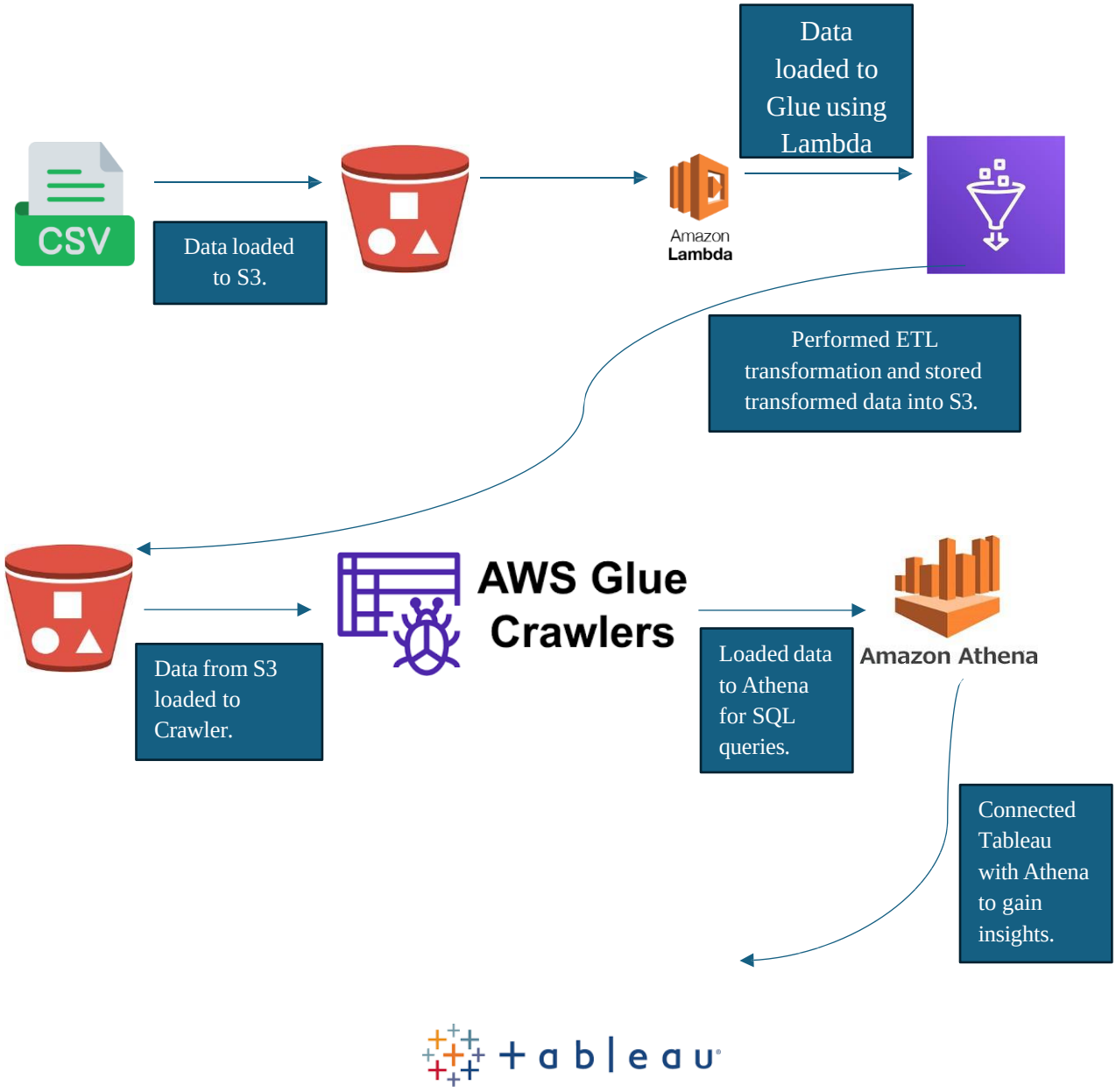
7. Fact Table:

- Price: Price per night for the listing.
- Weekly_price: Price for a week's stay.
- Security_deposit: Amount of security deposit required.
- Cleaning_fees: Fees for cleaning the property.
- Extra_people_price: Price for additional guests beyond the included number.

Citation

https://www.kaggle.com/datasets/airbnb/boston

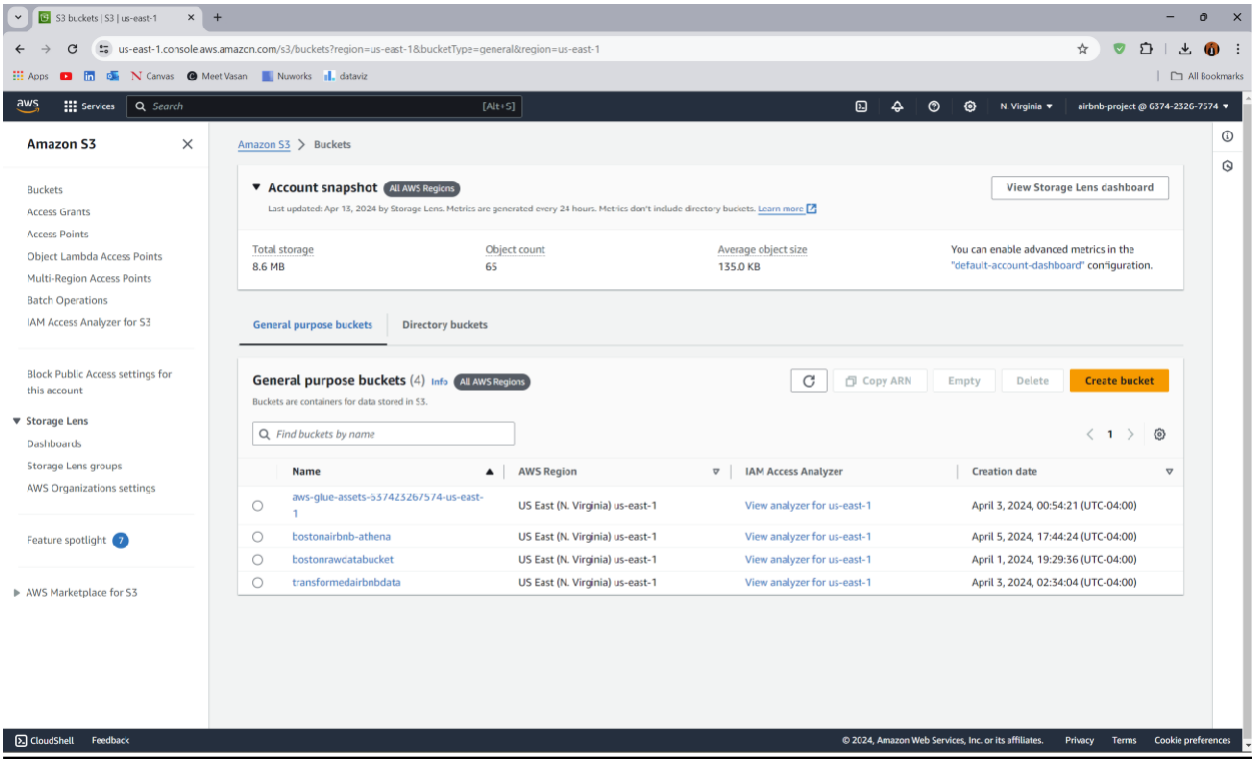
Data Architecture

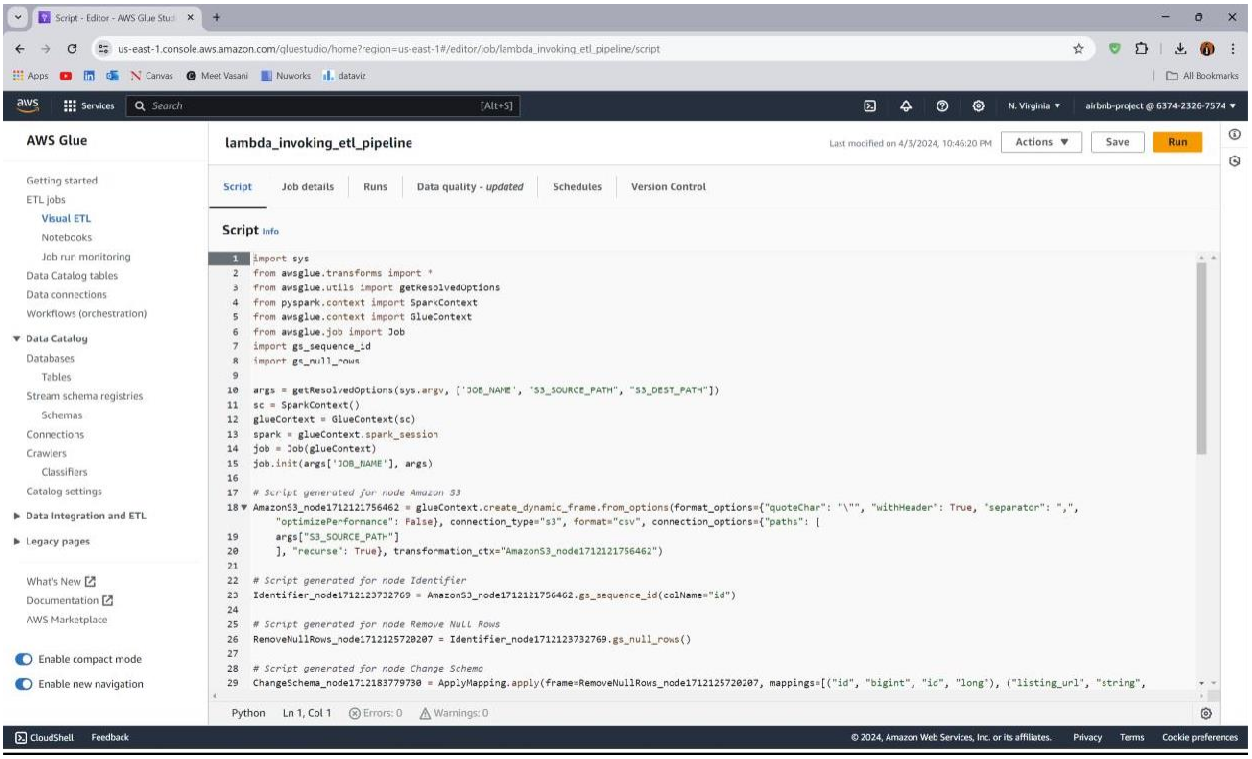


Data Ingestion

- Prepared structured data in CSV format.
- Created an S3 bucket, load csv file to S3.
- Used AWS lambda to fetch data from S3 and pass it to AWS glue.
- Used AWS glue for ETL to transform data.
- After transformation, sent data to the new S3 bucket.
- Loaded the transformed data to AWS Athena by AWS Glue Crawler.
- Used Athena to run queries and get granular insights from the data.

- Connected Athena with Tableau to visually get some insights.





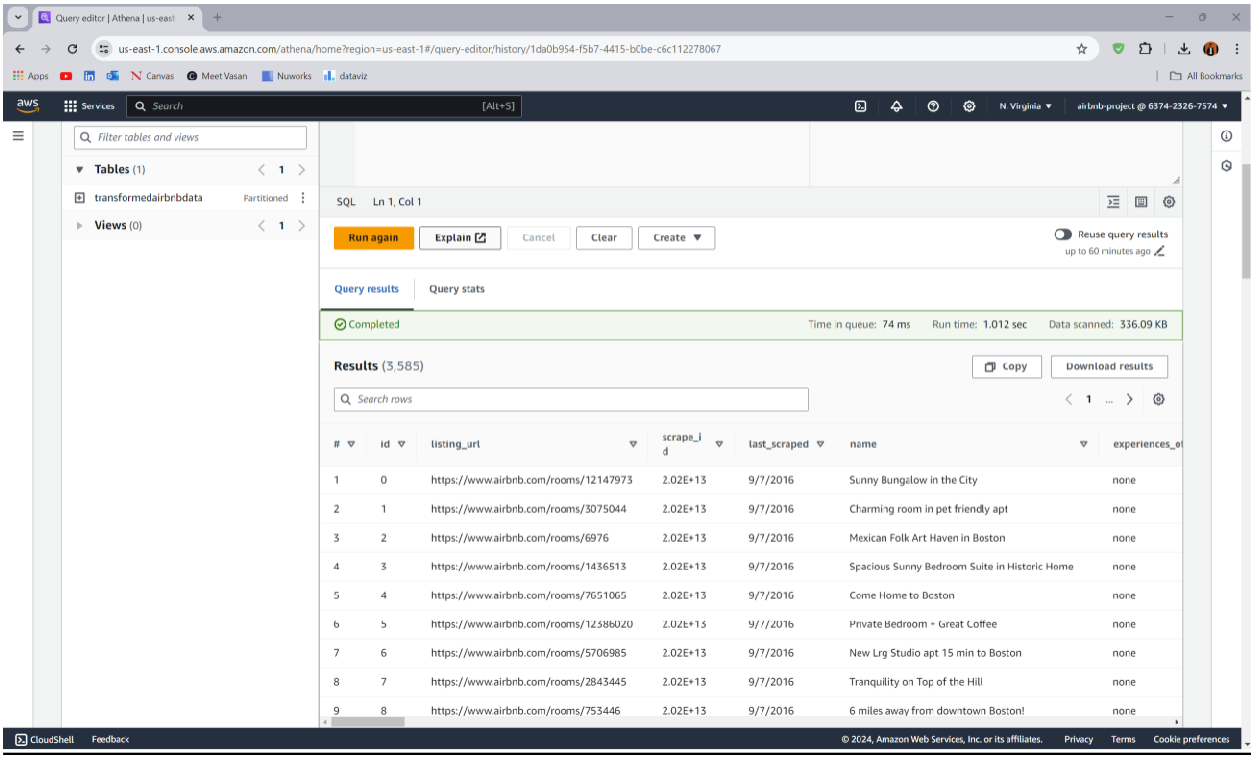


Tableau Dashboard