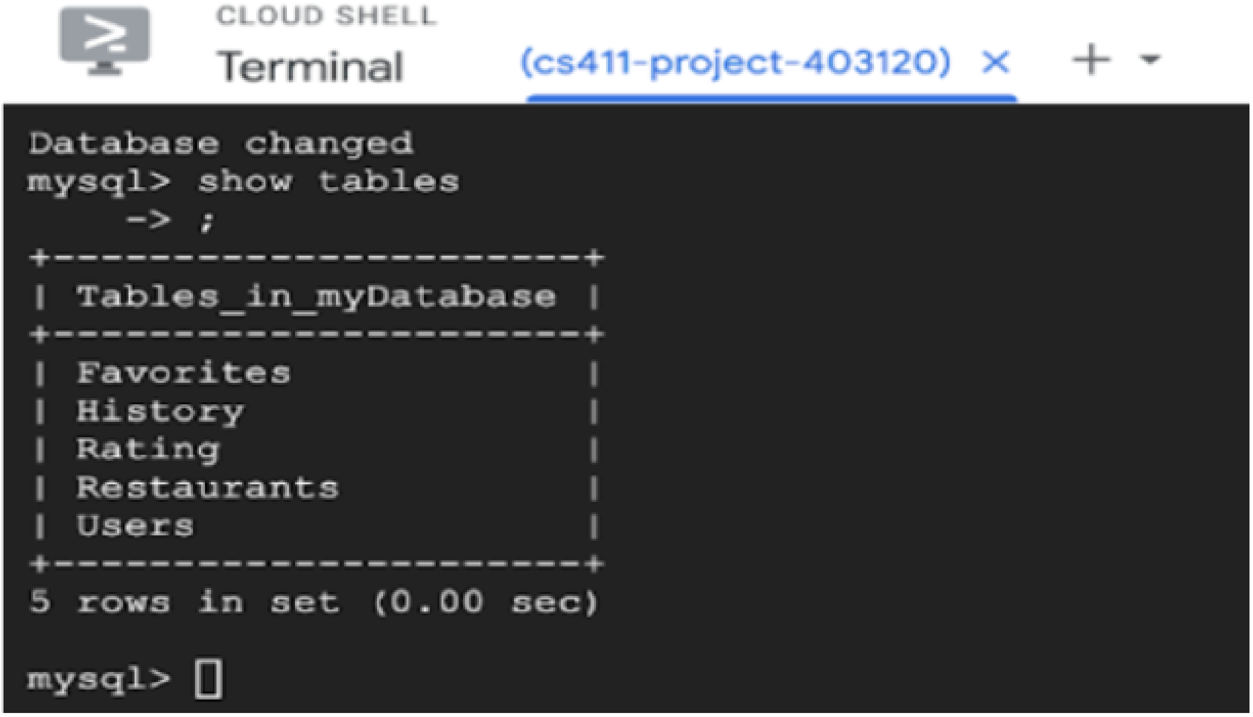
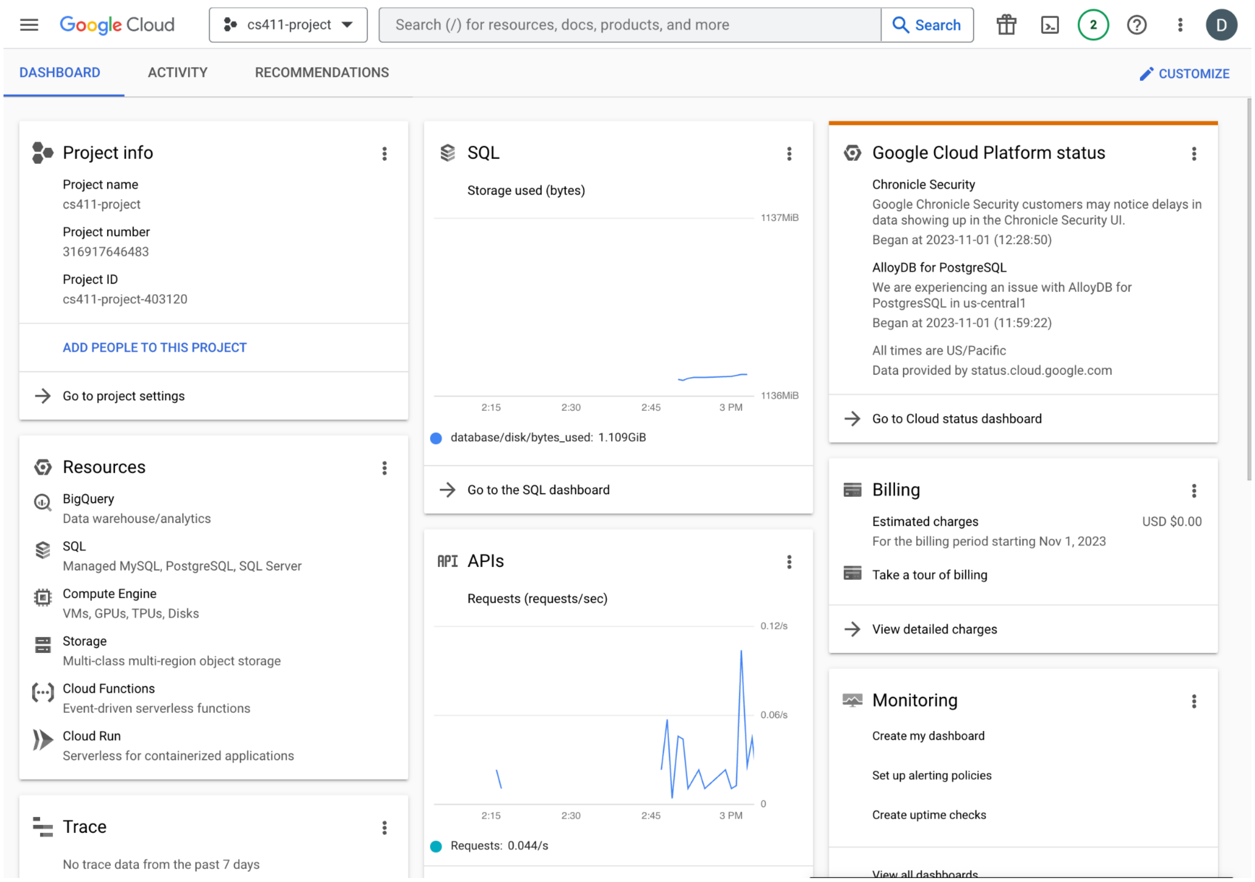
CS 411 stage 3

Database Implementation:



```
Database changed
mysql> show tables
    -> ;
+----------------------+
| Tables_in_myDatabase |
+----------------------+
| Favorites            |
| History              |
| Rating               |
| Restaurants          |
| Users                |
+----------------------+
5 rows in set (0.00 sec)

mysql> 
```



Project info

Project name
cs411-project

Project number
316917646483

Project ID
cs411-project-403120

ADD PEOPLE TO THIS PROJECT

Go to project settings

Resources

BigQuery
Data warehouse/analytics

SQL
Managed MySQL, PostgreSQL, SQL Server

Compute Engine
VMs, GPUs, TPUs, Disks

Storage
Multi-class multi-region object storage

Cloud Functions
Event-driven serverless functions

Cloud Run
Serverless for containerized applications

Trace

No trace data from the past 7 days

SQL

Storage used (bytes)

database/disk/bytes_used: 1.109GiB

Go to the SQL dashboard

APIs

Requests (requests/sec)

Requests: 0.044/s

Google Cloud Platform status

Chronicle Security
Google Chronicle Security customers may notice delays in data showing up in the Chronicle Security UI.
Began at 2023-11-01 (12:28:50)

AlloyDB for PostgreSQL
We are experiencing an issue with AlloyDB for PostgresSQL in us-central1
Began at 2023-11-01 (11:59:22)

All times are US/Pacific
Data provided by status.cloud.google.com

Go to Cloud status dashboard

Billing

Estimated charges USD $0.00
For the billing period starting Nov 1, 2023

Take a tour of billing

View detailed charges

Monitoring

Create my dashboard

Set up alerting policies

Create uptime checks

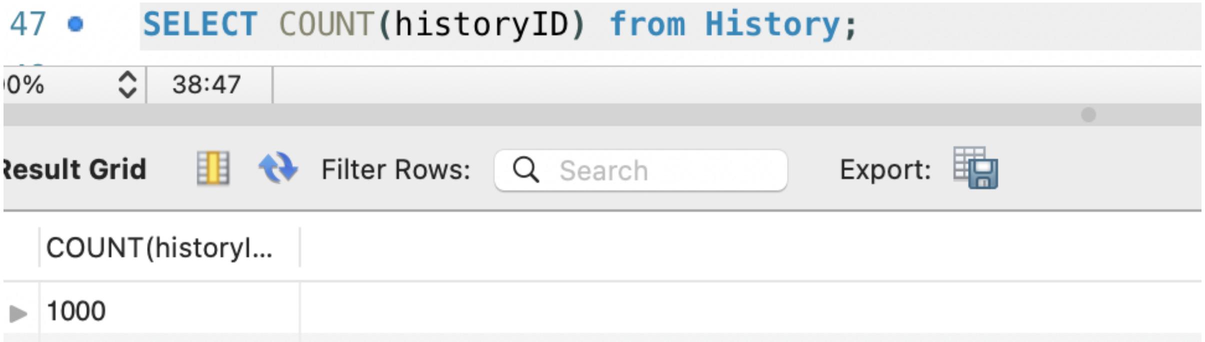
View all dashboards

020827

DDL Commands:

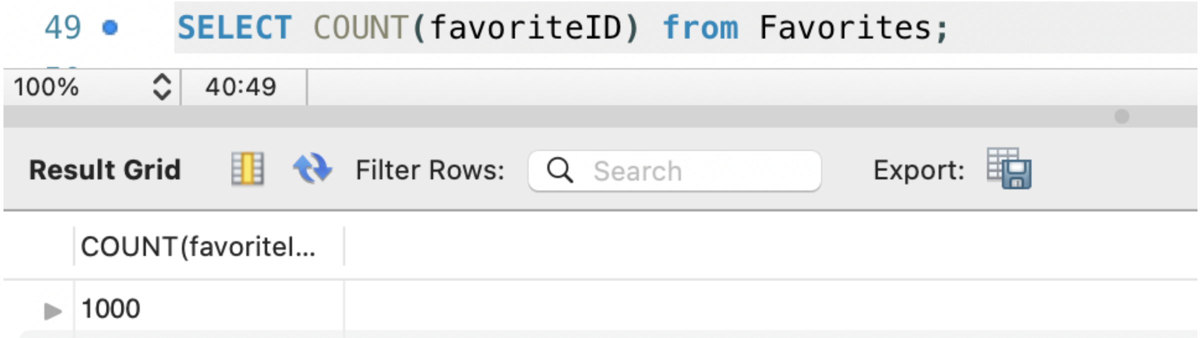
```
/* Table structure for table `Users` */
CREATE TABLE `Users` (
      `userID` INT NOT NULL,
      `userName` VARCHAR(255) NOT NULL,
      `password` VARCHAR(255) NOT NULL,
      PRIMARY KEY (`userID`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;

/* Table structure for table `Restaurants` */
CREATE TABLE `Restaurants` (
      `restaurantName` VARCHAR(255) NOT NULL,
      `style` VARCHAR(255) NOT NULL,
      `price` VARCHAR(255) NOT NULL,
      `address` VARCHAR(255) NOT NULL,
      `zip` VARCHAR(255) NOT NULL,
      PRIMARY KEY (`restaurantName`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;

/* Table structure for table `History` */
```

```
CREATE TABLE `History` (
    `historyID` INT NOT NULL,
    `userID` INT NOT NULL,
    `input` VARCHAR(255) NOT NULL,
    PRIMARY KEY (`historyID`),
    KEY `userID` (`userID`),
    CONSTRAINT `History_ibfk_1` FOREIGN KEY (`userID`) REFERENCES `Users` (`userID`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;

/* Table structure for table `Favorite` */
CREATE TABLE `Favorites` (
    `favoriteID` INT NOT NULL,
    `userID` INT NOT NULL,
    `restaurantName` VARCHAR(255) NOT NULL,
    `note` VARCHAR(255) NOT NULL,
    PRIMARY KEY (`favoriteID`),
    KEY `userID` (`userID`),
    KEY `restaurantName` (`restaurantName`),
    CONSTRAINT `Favorite_ibfk_1` FOREIGN KEY (`userID`) REFERENCES `Users` (`userID`),
    CONSTRAINT `Favorite_ibfk_2` FOREIGN KEY (`restaurantName`) REFERENCES `Restaurants`
        (`restaurantName`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;

/* Table structure for table `Rating` */
CREATE TABLE `Rating` (
    `ratingID` INT NOT NULL,
    `restaurantName` VARCHAR(255) NOT NULL,
    `score` INT NOT NULL,
    `comment` VARCHAR(10000) NOT NULL,
    PRIMARY KEY (`ratingID`),
    KEY `restaurantName` (`restaurantName`),
    CONSTRAINT `Rating_ibfk_1` FOREIGN KEY (`restaurantName`) REFERENCES `Restaurants`
        (`restaurantName`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
```



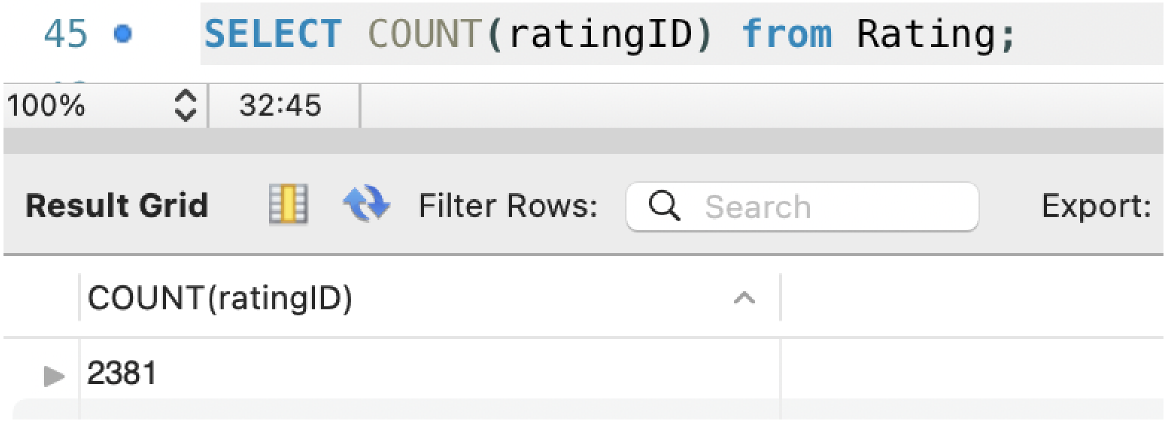
```sql
SELECT COUNT(historyID) from History;
```

```
COUNT(historyI...
1000
```



```sql
SELECT COUNT(favoriteID) from Favorites;
```

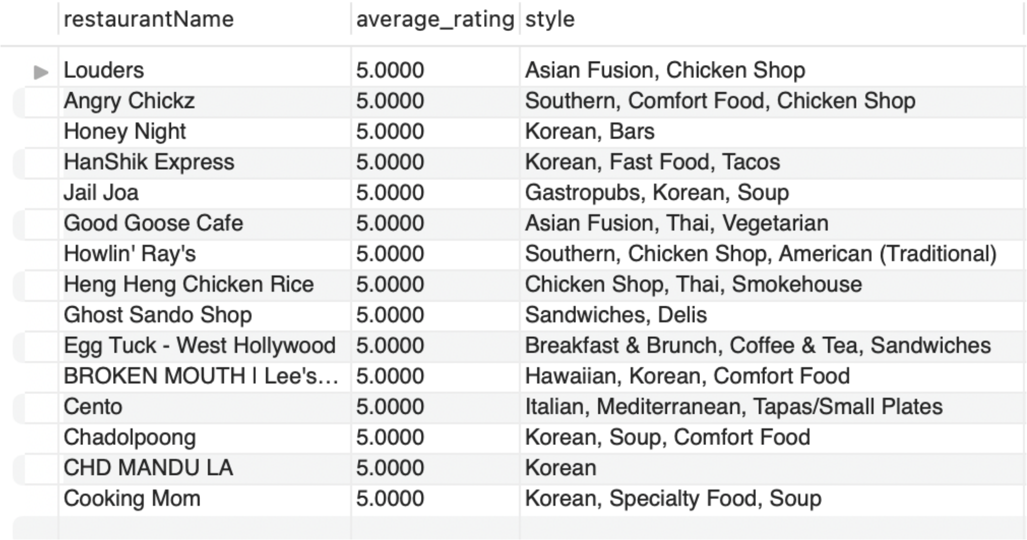
```
COUNT(favoriteI...
1000
```



```sql
SELECT COUNT(ratingID) from Rating;
```

```
COUNT(ratingID)
2381
```

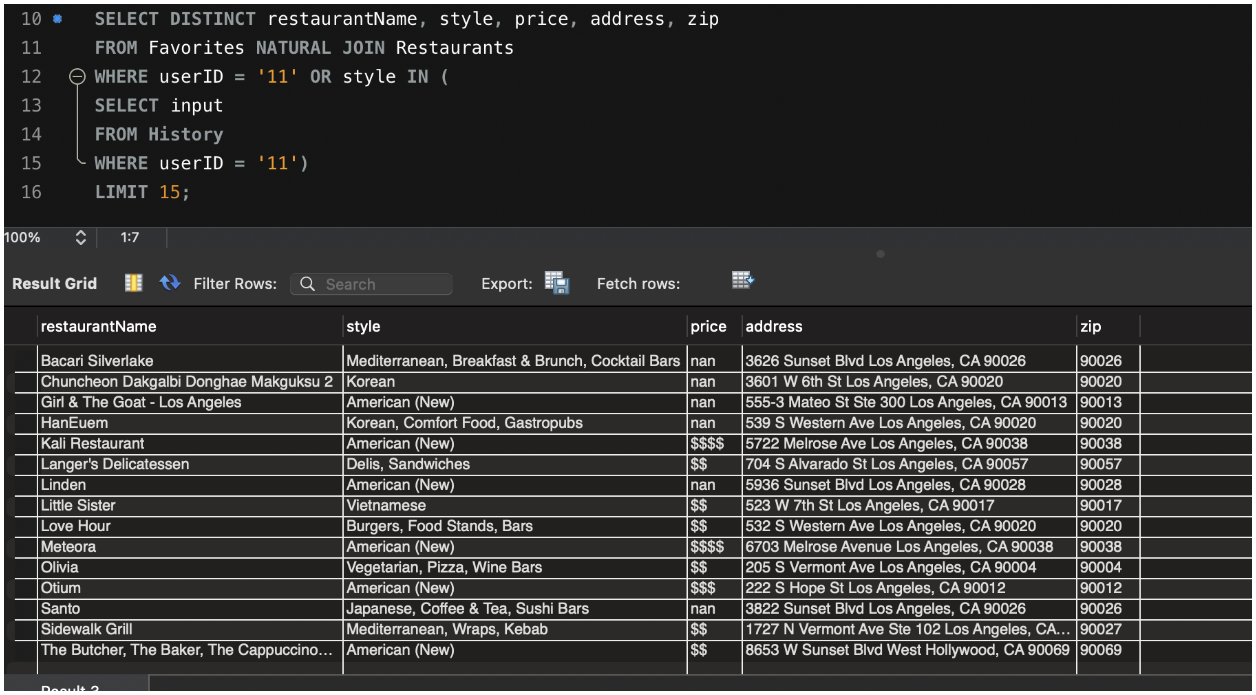
Advanced Queries:
SELECT restaurantName, AVG(score), style as average_rating
FROM Rating NATURAL JOIN Restaurants
WHERE price = '$$'
GROUP BY restaurantName
ORDER BY average_rating DESC;



restaurantName	average_rating	style
Louders	5.0000	Asian Fusion, Chicken Shop
Angry Chickz	5.0000	Southern, Comfort Food, Chicken Shop
Honey Night	5.0000	Korean, Bars
HanShik Express	5.0000	Korean, Fast Food, Tacos
Jail Joa	5.0000	Gastropubs, Korean, Soup
Good Goose Cafe	5.0000	Asian Fusion, Thai, Vegetarian
Howlin' Ray's	5.0000	Southern, Chicken Shop, American (Traditional)
Heng Heng Chicken Rice	5.0000	Chicken Shop, Thai, Smokehouse
Ghost Sando Shop	5.0000	Sandwiches, Delis
Egg Tuck - West Hollywood	5.0000	Breakfast & Brunch, Coffee & Tea, Sandwiches
BROKEN MOUTH I Lee's…	5.0000	Hawaiian, Korean, Comfort Food
Cento	5.0000	Italian, Mediterranean, Tapas/Small Plates
Chadolpoong	5.0000	Korean, Soup, Comfort Food
CHD MANDU LA	5.0000	Korean
Cooking Mom	5.0000	Korean, Specialty Food, Soup

(We select all restaurants that the price is ranged within “$$”)

```
SELECT DISTINCT restaurantName, style, price, address, zip
FROM Favorites NATURAL JOIN Restaurants
WHERE userID = '11' OR style IN (
SELECT input
FROM History
WHERE userID = '11');
```



```
SELECT DISTINCT restaurantName, style, price, address, zip
FROM Favorites NATURAL JOIN Restaurants
WHERE userID = '11' OR style IN (
SELECT input
FROM History
WHERE userID = '11')
LIMIT 15;
```


restaurantName	style	price	address	zip
Bacari Silverlake	Mediterranean, Breakfast & Brunch, Cocktail Bars	nan	3626 Sunset Blvd Los Angeles, CA 90026	90026
Chuncheon Dakgalbi Donghae Makguksu 2	Korean	nan	3601 W 6th St Los Angeles, CA 90020	90020
Girl & The Goat - Los Angeles	American (New)	nan	555-3 Mateo St Ste 300 Los Angeles, CA 90013	90013
HanEuem	Korean, Comfort Food, Gastropubs	nan	539 S Western Ave Los Angeles, CA 90020	90020
Kali Restaurant	American (New)	$$$$	5722 Melrose Ave Los Angeles, CA 90038	90038
Langer's Delicatessen	Delis, Sandwiches	$$	704 S Alvarado St Los Angeles, CA 90057	90057
Linden	American (New)	nan	5936 Sunset Blvd Los Angeles, CA 90028	90028
Little Sister	Vietnamese	$$	523 W 7th St Los Angeles, CA 90017	90017
Love Hour	Burgers, Food Stands, Bars	$$	532 S Western Ave Los Angeles, CA 90020	90020
Meteora	American (New)	$$$$	6703 Melrose Avenue Los Angeles, CA 90038	90038
Olivia	Vegetarian, Pizza, Wine Bars	$$	205 S Vermont Ave Los Angeles, CA 90004	90004
Otium	American (New)	$$$	222 S Hope St Los Angeles, CA 90012	90012
Santo	Japanese, Coffee & Tea, Sushi Bars	nan	3822 Sunset Blvd Los Angeles, CA 90026	90026
Sidewalk Grill	Mediterranean, Wraps, Kebab	$$	1727 N Vermont Ave Ste 102 Los Angeles, CA…	90027
The Butcher, The Baker, The Cappuccino…	American (New)	$$	8653 W Sunset Blvd West Hollywood, CA 90069	90069

(We select all restaurants that are in the favorite list of the user with id = 11)

Indexing:
Query 1:

The evaluation of the EXPLAIN ANALYZE outputs from different indexing strategies shows that while all indices improve query performance, the index on the style column (idx_style) emerges as the most effective. This indexing approach yields the quickest sort and nested loop join times (actual time=3.370..3.370), indicating superior query performance. Although the idx_price index reduced join times slightly, it added some overhead to the Restaurants lookup. Conversely, the idx_score index didn't offer notable improvements over the no-index scenario. Therefore, for this specific query, the idx_style index is optimal. However, real-world performance can vary based on database workload and dataset size, necessitating ongoing monitoring and potential adjustments.

1. EXPLAIN ANALYZE with no index

```
'-> Sort: average_rating DESC  (actual time=4.171..4.182 rows=123 loops=1)
    -> Table scan on <temporary>  (actual time=4.029..4.096 rows=123 loops=1)
        -> Aggregate using temporary table  (actual time=4.027..4.027 rows=123 loops=1)
            -> Nested loop inner join  (cost=103.28 rows=226) (actual time=0.114..2.939
rows=1266 loops=1)
                -> Filter: (Restaurants.price = "$$")  (cost=24.35 rows=24) (actual
time=0.078..0.216 rows=123 loops=1)
                    -> Table scan on Restaurants  (cost=24.35 rows=236) (actual
time=0.067..0.174 rows=236 loops=1)
                -> Index lookup on Rating using restaurantName
(restaurantName=Restaurants.restaurantName)  (cost=2.43 rows=10) (actual
time=0.019..0.021 rows=10 loops=123)
'
```

2. CREATE INDEX idx_price ON Restaurants(price)

```
'-> Sort: average_rating DESC  (actual time=3.754..3.764 rows=123 loops=1)
    -> Table scan on <temporary>  (actual time=3.649..3.678 rows=123 loops=1)
        -> Aggregate using temporary table  (actual time=3.645..3.645 rows=123 loops=1)
            -> Nested loop inner join  (cost=425.94 rows=1175) (actual time=0.199..2.535
rows=1266 loops=1)
                -> Index lookup on Restaurants using idx_price (price="$$")  (cost=14.55
rows=123) (actual time=0.174..0.276 rows=123 loops=1)
                -> Index lookup on Rating using restaurantName
(restaurantName=Restaurants.restaurantName)  (cost=2.40 rows=10) (actual
time=0.015..0.017 rows=10 loops=123)
'
```

3. CREATE INDEX idx_score ON Rating(score)

   ```
   -> Sort: average_rating DESC  (actual time=3.749..3.759 rows=123 loops=1)
      -> Table scan on <temporary>  (actual time=3.627..3.659 rows=123 loops=1)
         -> Aggregate using temporary table  (actual time=3.625..3.625 rows=123 loops=1)
            -> Nested loop inner join  (cost=103.28 rows=226) (actual time=0.119..2.543
   rows=1266 loops=1)
               -> Filter: (Restaurants.price = '$$')  (cost=24.35 rows=24) (actual
   time=0.077..0.201 rows=123 loops=1)
                  -> Table scan on Restaurants  (cost=24.35 rows=236) (actual
   time=0.075..0.172 rows=236 loops=1)
               -> Index lookup on Rating using restaurantName
   (restaurantName=Restaurants.restaurantName)  (cost=2.43 rows=10) (actual
   time=0.016..0.018 rows=10 loops=123)
   ```

4. CREATE INDEX idx_style ON Restaurants(style);

   ```
   '-> Sort: average_rating DESC  (actual time=3.469..3.479 rows=123 loops=1)
      -> Table scan on <temporary>  (actual time=3.372..3.401 rows=123 loops=1)
         -> Aggregate using temporary table  (actual time=3.370..3.370 rows=123 loops=1)
            -> Nested loop inner join  (cost=103.28 rows=226) (actual time=0.082..2.327
   rows=1266 loops=1)
               -> Filter: (Restaurants.price = "$$")  (cost=24.35 rows=24) (actual
   time=0.053..0.167 rows=123 loops=1)
                  -> Table scan on Restaurants  (cost=24.35 rows=236) (actual
   time=0.051..0.139 rows=236 loops=1)
               -> Index lookup on Rating using restaurantName
   (restaurantName=Restaurants.restaurantName)  (cost=2.43 rows=10) (actual
   time=0.014..0.017 rows=10 loops=123)
   '
   ```

Query 2:

The EXPLAIN ANALYZE outputs for Query 2 reveal that, among the different indexing strategies on the Restaurants table, the index on the price column (idx_price) significantly outperforms the others, including the scenarios with no index, an index on style (idx_style), and an index on zip (idx_zip). While the cost estimates for the indexed scenarios are identical (reduce 1184.04..1198.58 to 458.40..472.93), the actual time taken to execute the query is lowest with the price index, clocking in at 2.925..2.928 seconds compared to over 34 seconds without any index. This marked improvement underscores the effectiveness of the price index in optimizing the query's performance.

1. EXPLAIN ANALYZE with no index

```
'-> Table scan on <temporary>  (cost=1184.04..1198.58 rows=965) (actual
time=34.493..34.496 rows=16 loops=1)
    -> Temporary table with deduplication  (cost=1184.03..1184.03 rows=965) (actual
time=34.489..34.489 rows=16 loops=1)
        -> Nested loop inner join  (cost=1087.57 rows=965) (actual time=29.643..34.408
rows=42 loops=1)
            -> Table scan on Restaurants  (cost=26.60 rows=236) (actual
time=19.414..20.219 rows=236 loops=1)
            -> Filter: ((Favorites.userID = 11) or
<in_optimizer>(Restaurants.style,Restaurants.style in (select #2)))  (cost=4.09 rows=4)
(actual time=0.060..0.060 rows=0 loops=236)
                -> Index lookup on Favorites using restaurantName
(restaurantName=Restaurants.restaurantName)  (cost=4.09 rows=4) (actual
time=0.042..0.044 rows=4 loops=236)
                -> Select #2 (subquery in condition; run only once)
                    -> Filter: ((Restaurants.style = `<materialized_subquery>`.input))
(cost=15.30..15.30 rows=1) (actual time=0.015..0.015 rows=0 loops=230)
                        -> Limit: 1 row(s)  (cost=15.20..15.20 rows=1) (actual time=0.014..0.014
rows=0 loops=230)
                            -> Index lookup on <materialized_subquery> using
<auto_distinct_key> (input=Restaurants.style)  (actual time=0.014..0.014 rows=0
loops=230)
                                -> Materialize with deduplication  (cost=15.20..15.20 rows=16)
(actual time=3.082..3.082 rows=14 loops=1)
                                    -> Index lookup on History using userID (userID=11)  (cost=13.60
rows=16) (actual time=3.048..3.054 rows=16 loops=1)
'
```

2. CREATE INDEX idx_style ON Restaurants(style);

```
'-> Table scan on <temporary>  (cost=458.40..472.93 rows=965) (actual
time=4.718..4.722 rows=16 loops=1)
    -> Temporary table with deduplication  (cost=458.38..458.38 rows=965) (actual
time=4.715..4.715 rows=16 loops=1)
        -> Nested loop inner join  (cost=361.93 rows=965) (actual time=0.622..4.604
rows=42 loops=1)
            -> Table scan on Restaurants  (cost=24.35 rows=236) (actual time=0.085..0.317
rows=236 loops=1)
            -> Filter: ((Favorites.userID = 11) or
<in_optimizer>(Restaurants.style,Restaurants.style in (select #2)))  (cost=1.02 rows=4)
(actual time=0.018..0.018 rows=0 loops=236)
```

```
                -> Index lookup on Favorites using restaurantName
(restaurantName=Restaurants.restaurantName)  (cost=1.02 rows=4) (actual
time=0.013..0.015 rows=4 loops=236)
                -> Select #2 (subquery in condition; run only once)
                    -> Filter: ((Restaurants.style = `<materialized_subquery>`.input))
(cost=6.30..6.30 rows=1) (actual time=0.001..0.001 rows=0 loops=230)
                        -> Limit: 1 row(s)  (cost=6.20..6.20 rows=1) (actual time=0.001..0.001
rows=0 loops=230)
                            -> Index lookup on <materialized_subquery> using
<auto_distinct_key> (input=Restaurants.style)  (actual time=0.001..0.001 rows=0
loops=230)
                                -> Materialize with deduplication  (cost=6.20..6.20 rows=16) (actual
time=0.075..0.075 rows=14 loops=1)
                                    -> Index lookup on History using userID (userID=11)  (cost=4.60
rows=16) (actual time=0.055..0.059 rows=16 loops=1)
'
```

3. CREATE INDEX idx_price ON Restaurants(price)

```
'-> Table scan on <temporary>  (cost=458.40..472.93 rows=965) (actual
time=2.925..2.928 rows=16 loops=1)
    -> Temporary table with deduplication  (cost=458.38..458.38 rows=965) (actual
time=2.922..2.922 rows=16 loops=1)
        -> Nested loop inner join  (cost=361.93 rows=965) (actual time=0.355..2.865
rows=42 loops=1)
            -> Table scan on Restaurants  (cost=24.35 rows=236) (actual time=0.096..0.230
rows=236 loops=1)
            -> Filter: ((Favorites.userID = 11) or
<in_optimizer>(Restaurants.style,Restaurants.style in (select #2)))  (cost=1.02 rows=4)
(actual time=0.011..0.011 rows=0 loops=236)
                -> Index lookup on Favorites using restaurantName
(restaurantName=Restaurants.restaurantName)  (cost=1.02 rows=4) (actual
time=0.007..0.009 rows=4 loops=236)
                -> Select #2 (subquery in condition; run only once)
                    -> Filter: ((Restaurants.style = `<materialized_subquery>`.input))
(cost=6.30..6.30 rows=1) (actual time=0.001..0.001 rows=0 loops=230)
                        -> Limit: 1 row(s)  (cost=6.20..6.20 rows=1) (actual time=0.001..0.001
rows=0 loops=230)
                            -> Index lookup on <materialized_subquery> using
<auto_distinct_key> (input=Restaurants.style)  (actual time=0.001..0.001 rows=0
loops=230)
                                -> Materialize with deduplication  (cost=6.20..6.20 rows=16) (actual
time=0.072..0.072 rows=14 loops=1)
                                    -> Index lookup on History using userID (userID=11)  (cost=4.60
rows=16) (actual time=0.055..0.058 rows=16 loops=1)
```

'

4. CREATE INDEX idx_zip ON Restaurants(zip)

```
'-> Table scan on <temporary>  (cost=458.40..472.93 rows=965) (actual
time=5.218..5.223 rows=16 loops=1)
    -> Temporary table with deduplication  (cost=458.38..458.38 rows=965) (actual
time=5.215..5.215 rows=16 loops=1)
        -> Nested loop inner join  (cost=361.93 rows=965) (actual time=0.462..5.121
rows=42 loops=1)
            -> Table scan on Restaurants  (cost=24.35 rows=236) (actual time=0.111..0.437
rows=236 loops=1)
            -> Filter: ((Favorites.userID = 11) or
<in_optimizer>(Restaurants.style,Restaurants.style in (select #2)))  (cost=1.02 rows=4)
(actual time=0.019..0.020 rows=0 loops=236)
                -> Index lookup on Favorites using restaurantName
(restaurantName=Restaurants.restaurantName)  (cost=1.02 rows=4) (actual
time=0.013..0.015 rows=4 loops=236)
                -> Select #2 (subquery in condition; run only once)
                    -> Filter: ((Restaurants.style = `<materialized_subquery>`.input))
(cost=6.30..6.30 rows=1) (actual time=0.002..0.002 rows=0 loops=230)
                        -> Limit: 1 row(s)  (cost=6.20..6.20 rows=1) (actual time=0.002..0.002
rows=0 loops=230)
                            -> Index lookup on <materialized_subquery> using
<auto_distinct_key> (input=Restaurants.style)  (actual time=0.002..0.002 rows=0
loops=230)
                                -> Materialize with deduplication  (cost=6.20..6.20 rows=16) (actual
time=0.090..0.090 rows=14 loops=1)
                                    -> Index lookup on History using userID (userID=11)  (cost=4.60
rows=16) (actual time=0.071..0.076 rows=16 loops=1)
'
```