Міністерство освіти і науки України
Національний технічний університет України “Київський політехнічний інститут імені Ігоря Сікорського”
Факультет інформатики та обчислювальної техніки

Кафедра інформатики та програмної інженерії

Звіт

з лабораторної роботи №1
з дисципліни
“Програмування інтелектуальних інформаційних систем”

Виконала ІП-21 Скрипець О. О.

Перевірив Баришич Л. М.

Київ 2024

Завдання

1. Створити стовпчикову і звичайну бд
https://github.com/mariadb-corporation/mariadb-columnstore-sample-data
(приклад застосунку https://github.com/orgs/mariadb-developers/repositories?q=flights-app&language=)
В звичайній БД створити materialized view
2 Порахувати кількість польотів по містах
3 Знайти місто з найменшою і найбільшою затримкою
3 Заміряти вбудованими методами об"єм БД та швидкість виконання запитів. Порівняти звичайну і стовпчикову. Виміряти швидкість оновлення мат вью

Виконання

1. Створення columnstore_bts.

```
DROP DATABASE IF EXISTS `columnstore_bts`;

CREATE DATABASE `columnstore_bts`;

USE `columnstore_bts`;

CREATE TABLE `airlines` (
  `iata_code` varchar(2) DEFAULT NULL,
  `airline` varchar(30) DEFAULT NULL
) ENGINE=Columnstore DEFAULT CHARSET=utf8mb3
    COLLATE=utf8mb3_general_ci;

CREATE TABLE `airports` (
  `iata_code` varchar(3) DEFAULT NULL,
  `airport` varchar(80) DEFAULT NULL,
  `city` varchar(30) DEFAULT NULL,
  `state` varchar(2) DEFAULT NULL,
  `country` varchar(30) DEFAULT NULL,
  `latitude` decimal(11,4) DEFAULT NULL,
  `longitude` decimal(11,4) DEFAULT NULL
) ENGINE=Columnstore DEFAULT CHARSET=utf8mb3
    COLLATE=utf8mb3_general_ci;

CREATE TABLE `flights` (
```

```
    `year` smallint(6) DEFAULT NULL,
    `month` tinyint(4) DEFAULT NULL,
    `day` tinyint(4) DEFAULT NULL,
    `day_of_week` tinyint(4) DEFAULT NULL,
    `fl_date` date DEFAULT NULL,
    `carrier` varchar(2) DEFAULT NULL,
    `tail_num` varchar(6) DEFAULT NULL,
    `fl_num` smallint(6) DEFAULT NULL,
    `origin` varchar(5) DEFAULT NULL,
    `dest` varchar(5) DEFAULT NULL,
    `crs_dep_time` varchar(4) DEFAULT NULL,
    `dep_time` varchar(4) DEFAULT NULL,
    `dep_delay` decimal(13,2) DEFAULT NULL,
    `taxi_out` decimal(13,2) DEFAULT NULL,
    `wheels_off` varchar(4) DEFAULT NULL,
    `wheels_on` varchar(4) DEFAULT NULL,
    `taxi_in` decimal(13,2) DEFAULT NULL,
    `crs_arr_time` varchar(4) DEFAULT NULL,
    `arr_time` varchar(4) DEFAULT NULL,
    `arr_delay` decimal(13,2) DEFAULT NULL,
    `cancelled` decimal(13,2) DEFAULT NULL,
    `cancellation_code` varchar(20) DEFAULT NULL,
    `diverted` decimal(13,2) DEFAULT NULL,
    `crs_elapsed_time` decimal(13,2) DEFAULT NULL,
    `actual_elapsed_time` decimal(13,2) DEFAULT NULL,
    `air_time` decimal(13,2) DEFAULT NULL,
    `distance` decimal(13,2) DEFAULT NULL,
    `carrier_delay` decimal(13,2) DEFAULT NULL,
    `weather_delay` decimal(13,2) DEFAULT NULL,
    `nas_delay` decimal(13,2) DEFAULT NULL,
    `security_delay` decimal(13,2) DEFAULT NULL,
    `late_aircraft_delay` decimal(13,2) DEFAULT NULL
) ENGINE=Columnstore DEFAULT CHARSET=utf8mb3
COLLATE=utf8mb3_general_ci;
```

2. Створення innodb_bts

```
DROP DATABASE IF EXISTS `innodb_bts`;

CREATE DATABASE `innodb_bts`;

USE `innodb_bts`;

CREATE TABLE `airlines` (
  `iata_code` varchar(2) NOT NULL,
  `airline` varchar(30) DEFAULT NULL,
  PRIMARY KEY (`iata_code`),
  KEY `airline` (`airline`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb3
    COLLATE=utf8mb3_general_ci;

CREATE TABLE `airports` (
  `iata_code` varchar(3) NOT NULL,
  `airport` varchar(80) DEFAULT NULL,
  `city` varchar(30) DEFAULT NULL,
  `state` varchar(2) DEFAULT NULL,
  `country` varchar(30) DEFAULT NULL,
  `latitude` decimal(11,4) DEFAULT NULL,
  `longitude` decimal(11,4) DEFAULT NULL,
  PRIMARY KEY (`iata_code`),
  KEY `state` (`state`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb3
    COLLATE=utf8mb3_general_ci;

CREATE TABLE `flights` (
  `year` smallint(6) DEFAULT NULL,
  `month` tinyint(4) DEFAULT NULL,
  `day` tinyint(4) DEFAULT NULL,
  `day_of_week` tinyint(4) DEFAULT NULL,
  `fl_date` date DEFAULT NULL,
  `carrier` varchar(2) DEFAULT NULL,
  `tail_num` varchar(6) DEFAULT NULL,
  `fl_num` smallint(6) DEFAULT NULL,
```

```
  `origin` varchar(5) DEFAULT NULL,
  `dest` varchar(5) NOT NULL,
  `crs_dep_time` varchar(4) DEFAULT NULL,
  `dep_time` varchar(4) DEFAULT NULL,
  `dep_delay` decimal(13,2) DEFAULT NULL,
  `taxi_out` decimal(13,2) DEFAULT NULL,
  `wheels_off` varchar(4) DEFAULT NULL,
  `wheels_on` varchar(4) DEFAULT NULL,
  `taxi_in` decimal(13,2) DEFAULT NULL,
  `crs_arr_time` varchar(4) DEFAULT NULL,
  `arr_time` varchar(4) DEFAULT NULL,
  `arr_delay` decimal(13,2) DEFAULT NULL,
  `cancelled` decimal(13,2) DEFAULT NULL,
  `cancellation_code` varchar(20) DEFAULT NULL,
  `diverted` decimal(13,2) DEFAULT NULL,
  `crs_elapsed_time` decimal(13,2) DEFAULT NULL,
  `actual_elapsed_time` decimal(13,2) DEFAULT NULL,
  `air_time` decimal(13,2) DEFAULT NULL,
  `distance` decimal(13,2) DEFAULT NULL,
  `carrier_delay` decimal(13,2) DEFAULT NULL,
  `weather_delay` decimal(13,2) DEFAULT NULL,
  `nas_delay` decimal(13,2) DEFAULT NULL,
  `security_delay` decimal(13,2) DEFAULT NULL,
  `late_aircraft_delay` decimal(13,2) DEFAULT NULL,
  KEY `carrier` (`carrier`),
  KEY `year` (`year`),
  KEY `carrier_delay` (`carrier_delay`),
  KEY `weather_delay` (`weather_delay`),
  KEY `nas_delay` (`nas_delay`),
  KEY `security_delay` (`security_delay`),
  KEY `late_aircraft_delay` (`late_aircraft_delay`),
  KEY `arr_delay` (`arr_delay`),
  KEY `month` (`month`),
  KEY `dest` (`dest`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb3
    COLLATE=utf8mb3_general_ci;
```

3. Створення materialized view у звичайній бд

```
CREATE OR REPLACE VIEW city_flights_delays AS SELECT

a.city,
COUNT(f.fl_num) AS flight_count, SUM(CASE
WHEN f.origin = a.iata_code THEN COALESCE(f.dep_delay, 0)
    WHEN f.dest = a.iata_code THEN COALESCE(f.arr_delay, 0)
    ELSE 0
END) AS total_delay FROM
flights f JOIN
airports a ON f.origin = a.iata_code OR f.dest = a.iata_code GROUP
    BY
a.city;
```

```
MariaDB [innodb_bts]> CREATE OR REPLACE VIEW city_flights_delays AS SELECT
    ->
    -> a.city,
    -> COUNT(f.fl_num) AS flight_count, SUM(CASE
    -> WHEN f.origin = a.iata_code THEN COALESCE(f.dep_delay, 0) WHEN f.des
t = a.iata_code THEN COALESCE(f.arr_delay, 0) ELSE 0
    -> END) AS total_delay FROM
    -> flights f JOIN
    -> airports a ON f.origin = a.iata_code OR f.dest = a.iata_code GROUP B
Y
    -> a.city;
Query OK, 0 rows affected (0.030 sec)
```

4. Кількість польотів по містах у звичайній бд

```
SELECT city, flight_count
FROM city_flights_delays;
```

```
| West Palm Beach                |         11079 |
| White Plains                   |          3494 |
| Wichita                        |          3018 |
| Wichita Falls                  |           510 |
| Wilkes-Barre/Scranton          |           513 |
| Williston                      |          1079 |
| Wilmington                     |           731 |
| Windsor Locks                  |          7687 |
| Worcester                      |           234 |
| Wrangell                       |           276 |
| Yakutat                        |           274 |
| Yuma                           |           643 |
+--------------------------------+---------------+
301 rows in set (1 min 39.983 sec)
```

5. Кількість польотів по містах у стовпчиковій бд

```
SELECT
   a.city,
   SUM(acg.delay_sum) AS total_flight_count
FROM
   (
      SELECT
         a.airport,
         COUNT(a.airport) AS delay_sum
      FROM
         (
            SELECT origin AS airport FROM flights
            UNION ALL
            SELECT dest AS airport FROM flights
         ) AS a
      GROUP BY a.airport
   ) AS acg
JOIN airports a ON a.iata_code = acg.airport
GROUP BY a.city
ORDER BY a.city;
```

```
| Valparaiso                 |               1832 |
| Vernal                     |                202 |
| Waco                       |                718 |
| Waterloo                   |                278 |
| West Palm Beach            |              11079 |
| White Plains               |               3494 |
| Wichita                    |               3018 |
| Wichita Falls              |                510 |
| Wilkes-Barre/Scranton      |                513 |
| Williston                  |               1079 |
| Wilmington                 |                731 |
| Windsor Locks              |               7687 |
| Worcester                  |                234 |
| Wrangell                   |                276 |
| Yakutat                    |                274 |
| Yuma                       |                643 |
+----------------------------+--------------------+
301 rows in set (1.658 sec)
```

6. **Місто з найменшою та найбільшою затримкою у звичайній бд**

```
SELECT city, total_delay
FROM city_flights_delays
ORDER BY total_delay DESC
LIMIT 1;
```

```
MariaDB [innodb_bts]> SELECT city, total_delay FROM city_flights_delays OR
ER BY total_delay DESC LIMIT 1;
+---------+-------------+
| city    | total_delay |
+---------+-------------+
| Chicago |  1990719.00 |
+---------+-------------+
1 row in set (1 min 44.927 sec)
```

```
SELECT city, total_delay
FROM city_flights_delays
ORDER BY total_delay ASC
LIMIT 1;
```

```
MariaDB [innodb_bts]> SELECT city, total_delay
    -> FROM city_flights_delays
    -> ORDER BY total_delay ASC
    -> LIMIT 1;

+------+-------------+
| city | total_delay |
+------+-------------+
| Moab |    -2485.00 |
+------+-------------+
1 row in set (1 min 33.996 sec)
```

7. **Місто з найменшою та найбільшою затримкою у стовпчиковій бд**

```
SELECT city, SUM(total_delay) AS total_delay
FROM (
    SELECT airports.city, SUM(COALESCE(f.dep_delay, 0)) AS
    total_delay FROM flights f
    JOIN airports ON f.origin = airports.iata_code
    GROUP BY airports.city
    UNION ALL
```

```
        SELECT airports.city, SUM(COALESCE(f.arr_delay, 0)) AS total_delay
        FROM flights f
        JOIN airports ON f.dest =
        airports.iata_code GROUP BY
        airports.city
) AS city_delays
GROUP BY city
ORDER BY total_delay DESC
 LIMIT 1;
```

```
MariaDB [columnstore_bts]> SELECT city, SUM(total_delay) AS total_delay FR
M (
    -> SELECT airports.city, SUM(COALESCE(f.dep_delay, 0)) AS total_delay
ROM flights f
    -> JOIN airports ON f.origin = airports.iata_code GROUP BY airports.ci
y
    -> UNION ALL
    -> SELECT airports.city, SUM(COALESCE(f.arr_delay, 0)) AS total_delay
ROM flights f
    -> JOIN airports ON f.dest = airports.iata_code GROUP BY airports.city
    -> ) AS city_delays GROUP BY city
    -> ORDER BY total_delay DESC
    ->     LIMIT 1;
+---------+-------------+
| city    | total_delay |
+---------+-------------+
| Chicago |  1990719.00 |
+---------+-------------+
1 row in set (0.752 sec)
```

```
SELECT city, SUM(total_delay) AS total_delay
FROM (
   SELECT airports.city, SUM(COALESCE(f.dep_delay, 0)) AS total_delay
   FROM flights f
   JOIN airports ON f.origin = airports.iata_code GROUP
   BY airports.city
   UNION ALL
   SELECT airports.city, SUM(COALESCE(f.arr_delay, 0)) AS total_delay
   FROM flights f
```

```
    JOIN airports ON f.dest = airports.iata_code
    GROUP BY airports.city
) AS city_delays GROUP
BY city
ORDER BY total_delay ASC
LIMIT 1;
```

```
MariaDB [columnstore_bts]> SELECT city, SUM(total_delay) AS total_delay FR
M (
    -> SELECT airports.city, SUM(COALESCE(f.dep_delay, 0)) AS total_delay
ROM flights f
    -> JOIN airports ON f.origin = airports.iata_code GROUP BY airports.ci
y
    -> UNION ALL
    -> SELECT airports.city, SUM(COALESCE(f.arr_delay, 0)) AS total_delay
ROM flights f
    -> JOIN airports ON f.dest = airports.iata_code GROUP BY airports.city
    -> ) AS city_delays GROUP BY city
    -> ORDER BY total_delay ASC LIMIT 1;
+------+-------------+
| city | total_delay |
+------+-------------+
| Moab |    -2485.00 |
+------+-------------+
1 row in set (0.707 sec)
```

8. Об’єм звичайної бд

```
SELECT   table_name AS `Table`,
ROUND((data_length + index_length) / 1024 / 1024, 2)  AS `Size`
 FROM information_schema.tables
WHERE table_schema = 'innodb_bts';
```

```
MariaDB [innodb_bts]> SELECT
    ->
    -> table_name AS `Table`,
    -> ROUND((data_length + index_length) / 1024 / 1024, 2) AS `Size`
FROM
    -> information_schema.tables WHERE
    -> table_schema = 'innodb_bts';
+--------------------+-----------+
| Table              | Size      |
+--------------------+-----------+
| flights            |      0.17 |
| city_flights_delays |      NULL |
| airlines           |      0.03 |
| airports           |      0.03 |
+--------------------+-----------+
4 rows in set (0.055 sec)
```

9. Об’єм стовпчикової бд

call columnstore_info.table_usage('columnstore_bts', 'airports'); call

```
MariaDB [columnstore_bts]> call columnstore_info.table_usage('columnstore_ts', 'airports');
 call
+-----------------+------------+-----------------+-----------------+-------------+
| TABLE_SCHEMA    | TABLE_NAME | DATA_DISK_USAGE | DICT_DATA_USAGE | TOTAL_USAGE |
+-----------------+------------+-----------------+-----------------+-------------+
| columnstore_bts | airports   | 840.00 KB       | 872.00 KB       | 1.67 MB     |
+-----------------+------------+-----------------+-----------------+-------------+
1 row in set (0.225 sec)
```

columnstore_info.table_usage('columnstore_bts', 'airlines'); call

```
    -> columnstore_info.table_usage('columnstore_bts', 'airlines'); call
+-----------------+------------+-----------------+-----------------+-------------+
| TABLE_SCHEMA    | TABLE_NAME | DATA_DISK_USAGE | DICT_DATA_USAGE | TOTAL_USAGE |
+-----------------+------------+-----------------+-----------------+-------------+
| columnstore_bts | airlines   | 240.00 KB       | 216.00 KB       | 456.00 KB   |
+-----------------+------------+-----------------+-----------------+-------------+
1 row in set (0.152 sec)
```

columnstore_info.table_usage('columnstore_bts', 'flights');

```
    -> columnstore_info.table_usage('columnstore_bts', 'flights');
+-----------------+------------+-----------------+-----------------+-------------+
| TABLE_SCHEMA    | TABLE_NAME | DATA_DISK_USAGE | DICT_DATA_USAGE | TOTAL_USAGE |
+-----------------+------------+-----------------+-----------------+-------------+
| columnstore_bts | flights    | 52.23 MB        | 6.38 MB         | 58.61 MB    |
+-----------------+------------+-----------------+-----------------+-------------+
1 row in set (0.255 sec)
```

10. Швидкість виконання запитів

Запити	Швидкість	
	Звичайна бд	Стовпчикова бд
Кількість польотів по містах	1min 39.383 sec	1.658 sec
Місто з найбільшою затримкою	1 min 44.927 sec	0.752 sec
Місто з найменшою затримкою	1 min 33.996 sec	0.707 sec

11.Швидкість оновлення materialized view

```
MariaDB [columnstore_bts]> USE innodb_bts
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
MariaDB [innodb_bts]> CREATE OR REPLACE VIEW city_flights_delays AS SELECT
    ->
    -> a.city,
    -> COUNT(f.fl_num) AS flight_count, SUM(CASE
    -> WHEN f.origin = a.iata_code THEN COALESCE(f.dep_delay, 0) WHEN f.dest = a.iata_code
THEN COALESCE(f.arr_delay, 0) ELSE 0
    -> END) AS total_delay FROM
    -> flights f JOIN
    -> airports a ON f.origin = a.iata_code OR f.dest = a.iata_code GROUP BY
    -> a.city;
Query OK, 0 rows affected (0.028 sec)
```