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ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ ОБРАЗОВАТЕЛЬНОЕ  
УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ  
НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ ИТМО**

**ОТЧЕТ**

**ПО ЛАБОРАТОРНОЙ РАБОТЕ № 4**

**«ЗАПРОСЫ НА ВЫБОРКУ И МОДИФИКАЦИЮ ДАННЫХ.  
ПРЕДСТАВЛЕНИЯ. РАБОТА С ИНДЕКСАМИ»**

**по дисциплине «Проектирование и реализация баз данных»**

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**Группа К3239**

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**Образовательная программа Мобильные и сетевые технологии 2023**

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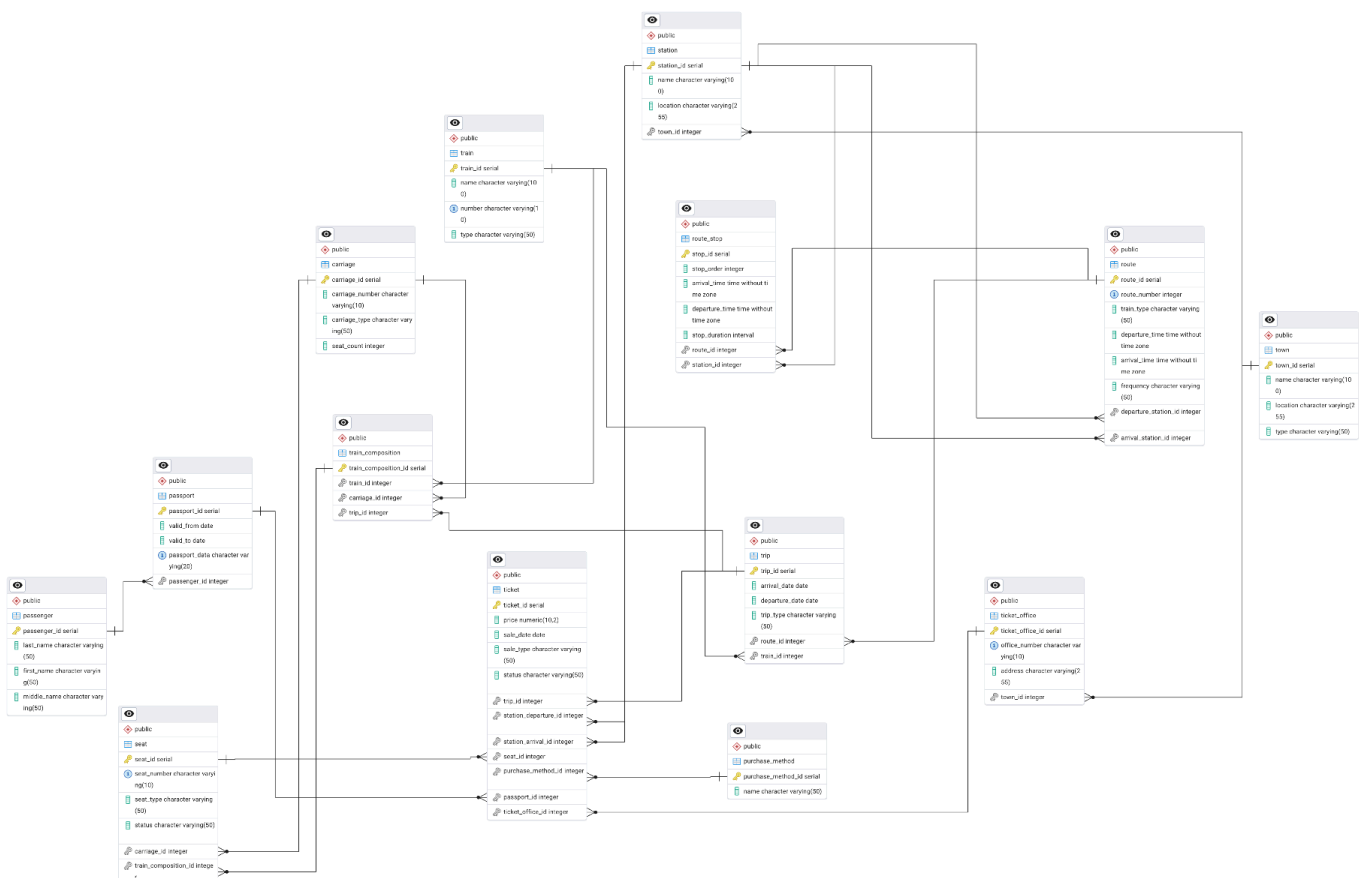
Санкт-Петербург  
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1. **Цель работы:** овладеть практическими навыками создания представлений и запросов на выборку данных к базе данных PostgreSQL, использования подзапросов при модификации данных и индексов.
2. **Практическое задание:**
  - Создать запросы и представления на выборку данных к базе данных PostgreSQL (согласно индивидуальному заданию лабораторной работы №2, часть 2 и 3).
  - Составить 3 запроса на модификацию данных (INSERT, UPDATE, DELETE) с использованием подзапросов.
  - Изучить графическое представление запросов и просмотреть историю запросов.
  - Создать простой и составной индексы для двух произвольных запросов и сравнить время выполнения запросов без индексов и с индексами. Для получения плана запроса использовать команду EXPLAIN.

#### 4. **Выполнение:**

1. Наименование создаваемой БД: **Rail Ticket Database**

2. Схема логической модели базы данных, сгенерированная в Generate ERD:



### 3. Скрипты запросов:

1.

```
SELECT
    tr.train_id,
    tr.number      AS train_number,
    tr.name        AS train_name,
    COUNT(s.seat_id)                AS total_seats,
    COUNT(tk.seat_id)               AS sold_seats,
    COUNT(s.seat_id) - COUNT(tk.seat_id) AS free_seats
FROM trip tp
JOIN route r ON tp.route_id = r.route_id
JOIN train tr ON tp.train_id = tr.train_id
JOIN train_composition tc ON tp.trip_id = tc.trip_id
JOIN seat s ON tc.train_composition_id = s.train_composition_id
LEFT JOIN ticket tk ON tk.trip_id = tp.trip_id AND tk.seat_id = s.seat_id AND
tk.status = 'Куплен'
WHERE r.departure_station_id = 2
    AND tp.departure_date = CURRENT_DATE + 1
GROUP BY tr.train_id, tr.number, tr.name;
```

2.

```
WITH daily_revenue AS (
    SELECT
        tr.train_id,
        tr.number      AS train_number,
        tr.name        AS train_name,
        SUM(tk.price)   AS total_revenue
    FROM ticket tk
    JOIN trip tp
        ON tk.trip_id = tp.trip_id
    JOIN train tr
        ON tp.train_id = tr.train_id
    WHERE tk.sale_date = CURRENT_DATE - 1
        AND tk.status = 'Куплен'
    GROUP BY tr.train_id, tr.number, tr.name
)
SELECT
    train_id,
    train_number,
    train_name,
    total_revenue
FROM daily_revenue
WHERE total_revenue = (
    SELECT MAX(total_revenue)
    FROM daily_revenue
);
```

3.

```
SELECT
    tr.number AS train_number
FROM trip tp
JOIN train tr ON tp.train_id = tr.train_id
JOIN train_composition tc ON tp.trip_id = tc.trip_id
JOIN seat s     ON tc.train_composition_id = s.train_composition_id
LEFT JOIN ticket tk
    ON tk.trip_id = tp.trip_id
AND tk.seat_id = s.seat_id
AND tk.status = 'Куплен'
WHERE tp.departure_date = CURRENT_DATE + 1
GROUP BY tr.number
HAVING COUNT(s.seat_id) = COUNT(tk.ticket_id);
```

4.

```
SELECT
    tp.trip_id,
    tr.number      AS train_number,
    tr.name        AS train_name,
    COUNT(s.seat_id) - COUNT(tk.ticket_id) AS free_coupe_seats
FROM trip tp
JOIN route r
    ON tp.route_id = r.route_id
JOIN station st
    ON r.arrival_station_id = st.station_id
JOIN town tw
    ON st.town_id = tw.town_id
AND tw.name = 'Москва'
JOIN train tr
    ON tp.train_id = tr.train_id
JOIN train_composition tc
    ON tp.trip_id = tc.trip_id
JOIN carriage c
    ON tc.carriage_id = c.carriage_id
AND c.carriage_type = 'Купе'
JOIN seat s
    ON s.train_composition_id = tc.train_composition_id
LEFT JOIN ticket tk
    ON tk.trip_id = tp.trip_id
AND tk.seat_id = s.seat_id
AND tk.status = 'Куплен'
WHERE tp.departure_date = CURRENT_DATE
GROUP BY tp.trip_id, tr.number, tr.name;
```

5.

```
SELECT
    SUM(tk.price) AS total_revenue
FROM ticket tk
```

```
WHERE tk.sale_date = CURRENT_DATE - 1
AND tk.status = 'Куплен';
```

6.

```
SELECT
    COUNT(*) AS total_sv_tickets
FROM ticket tk
JOIN seat s
    ON tk.seat_id = s.seat_id
JOIN carriage c
    ON s.carriage_id = c.carriage_id
WHERE c.carriage_type = 'CB'
AND tk.status = 'Куплен';
```

7.

```
SELECT
    tr.number AS train_number,
    tr.name AS train_name
FROM trip tp
JOIN train tr
    ON tp.train_id = tr.train_id
JOIN train_composition tc
    ON tp.trip_id = tc.trip_id
JOIN seat s
    ON tc.train_composition_id = s.train_composition_id
LEFT JOIN ticket tk
    ON tk.trip_id = tp.trip_id
AND tk.seat_id = s.seat_id
AND tk.status = 'Куплен'
WHERE tp.departure_date = CURRENT_DATE - 1
GROUP BY tr.train_id, tr.number, tr.name
HAVING
    COUNT(tk.ticket_id)::float
    /
    NULLIF(COUNT(s.seat_id), 0)
    < 0.5;
```

Представления:

### 1) free\_seats\_view

```
CREATE OR REPLACE VIEW free_seats_view AS
SELECT
    tp.trip_id,
    tr.number AS train_number,
    tr.name AS train_name,
    c.carriage_id,
    c.carriage_number,
    c.carriage_type,
```

```

        s.seat_id,
        s.seat_number,
        s.seat_type
FROM trip tp
JOIN train tr
    ON tp.train_id = tr.train_id
JOIN train_composition tc
    ON tp.trip_id = tc.trip_id
JOIN carriage c
    ON tc.carriage_id = c.carriage_id
JOIN seat s
    ON tc.train_composition_id = s.train_composition_id
WHERE s.status = 'Свободно'
;

```

## 2) unsold\_tickets\_yesterday

```

CREATE OR REPLACE VIEW unsold_tickets_yesterday AS
SELECT
    tr.number          AS train_number,
    c.carriage_type,
    COUNT(s.seat_id)
        - COUNT(tk.ticket_id)    AS unsold_tickets
FROM trip tp
JOIN train tr
    ON tp.train_id = tr.train_id
JOIN train_composition tc
    ON tp.trip_id = tc.trip_id
JOIN carriage c
    ON tc.carriage_id = c.carriage_id
JOIN seat s
    ON tc.train_composition_id = s.train_composition_id
LEFT JOIN ticket tk
    ON tk.trip_id = tp.trip_id
AND tk.seat_id = s.seat_id
AND tk.status = 'Куплен'
WHERE tp.departure_date = CURRENT_DATE - 1
GROUP BY tr.number, c.carriage_type
;

```

## Проверка:

```

SELECT *
FROM free_seats_view
WHERE trip_id = 1;

```

## Создание запросов на модификацию данных с подзапросами:

```
INSERT INTO ticket (  
    ticket_id, price, sale_date, sale_type, status,  
    trip_id, station_departure_id, station_arrival_id,  
    seat_id, purchase_method_id, passport_id, ticket_office_id  
)  
SELECT  
    (SELECT COALESCE(MAX(ticket_id), 0) FROM ticket) + ROW_NUMBER() OVER () AS  
ticket_id,  
    2500.00 AS price,  
    '2025-05-13' AS sale_date,  
    'Онлайн' AS sale_type,  
    'Куплен' AS status,  
    3 AS trip_id,  
    2 AS station_departure_id,  
    1 AS station_arrival_id,  
    s.seat_id,  
    1 AS purchase_method_id,  
    1 AS passport_id,  
    1 AS ticket_office_id  
FROM seat s  
JOIN train_composition tc ON s.train_composition_id = tc.train_composition_id  
JOIN carriage c ON tc.carriage_id = c.carriage_id  
WHERE tc.trip_id = 3  
    AND c.carriage_type = 'CB'  
    AND s.status = 'Свободно';
```

```
UPDATE ticket  
SET status = 'Возврат'  
WHERE ticket_id IN (  
    SELECT ticket_id  
    FROM ticket  
    WHERE price > 2000  
        AND status = 'Куплен'  
);
```

```
UPDATE ticket  
SET status = 'Возврат'  
WHERE ticket_id IN (  
    SELECT ticket_id  
    FROM ticket  
    WHERE price > 2000  
        AND status = 'Куплен'  
);
```

## Удаляем старые индексы:

```
DROP INDEX IF EXISTS idx_trip_departure_date;  
DROP INDEX IF EXISTS idx_route_departure_station;  
DROP INDEX IF EXISTS idx_seat_train_composition;  
DROP INDEX IF EXISTS idx_ticket_trip_seat_status;
```

## Замер без индексов:

```
EXPLAIN (ANALYZE, BUFFERS, FORMAT TEXT)  
SELECT  
    tr.train_id,  
    tr.number          AS train_number,  
    tr.name            AS train_name,  
    COUNT(s.seat_id)    AS total_seats,  
    COUNT(tk.ticket_id) AS sold_seats,  
    COUNT(s.seat_id) - COUNT(tk.ticket_id) AS free_seats  
FROM trip tp  
JOIN route r ON tp.route_id = r.route_id  
JOIN train tr ON tp.train_id = tr.train_id  
JOIN train_composition tc ON tp.trip_id = tc.trip_id  
JOIN seat s ON tc.train_composition_id = s.train_composition_id  
LEFT JOIN ticket tk  
    ON tk.trip_id = tp.trip_id  
AND tk.seat_id = s.seat_id  
AND tk.status = 'Куплен'  
WHERE r.departure_station_id = 2  
    AND tp.departure_date = CURRENT_DATE + 1  
GROUP BY tr.train_id, tr.number, tr.name;
```

Planning:
Buffers: shared hit=302
Planning Time: 2.527 ms
Execution Time: 0.515 ms

## Создадим индексы:

```
CREATE INDEX idx_trip_departure_date ON trip(departure_date);  
CREATE INDEX idx_route_departure_station ON route(departure_station_id);  
  
CREATE INDEX idx_seat_train_composition ON seat(train_composition_id);  
CREATE INDEX idx_ticket_trip_seat_status  
    ON ticket(trip_id, seat_id, status)  
    WHERE status = 'Куплен';
```



### Замер с индексами:

```
EXPLAIN (ANALYZE, BUFFERS, FORMAT TEXT)

SELECT
    tr.train_id,
    tr.number      AS train_number,
    tr.name        AS train_name,
    COUNT(s.seat_id)      AS total_seats,
    COUNT(tk.ticket_id)   AS sold_seats,
    COUNT(s.seat_id) - COUNT(tk.ticket_id) AS free_seats
FROM trip tp
JOIN route r ON tp.route_id = r.route_id
JOIN train tr ON tp.train_id = tr.train_id
JOIN train_composition tc ON tp.trip_id = tc.trip_id
JOIN seat s ON tc.train_composition_id = s.train_composition_id
LEFT JOIN ticket tk
    ON tk.trip_id = tp.trip_id
   AND tk.seat_id = s.seat_id
   AND tk.status = 'Куплен'
WHERE r.departure_station_id = 2
   AND tp.departure_date = CURRENT_DATE + 1
GROUP BY tr.train_id, tr.number, tr.name;
```

Planning:

Buffers: shared hit=320 read=4

Planning Time: 2.491 ms

Execution Time: 0.305 ms

**Выводы:** В ходе лабораторной работы была спроектирована и наполнена тестовая БД с учётом CHECK/FOREIGN KEY, разработаны и оптимизированы сложные SELECT-запросы, реализованы DML-операции с подзапросами, созданы удобные представления и подтверждена значительная выгода от индексирования.