НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ

«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ ІМЕНІ ІГОРЯ СІКОРСЬКОГО»

ФАКУЛЬТЕТ ПРИКЛАДНОЇ МАТЕМАТИКИ

Кафедра системного програмування та спеціалізованих комп'ютерних систем

Розрахункова графічна робота

з дисципліни **Бази даних і засоби управління**

на тему: " Засоби оптимізації роботи СУБД PostgreSQL"

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Київ – 2024

https://github.com/HomerLund/BD_Lab2.git

Метою роботи є здобуття практичних навичок використання засобів оптимізації СУБД PostgreSQL.

Завдання роботи полягає у наступному:

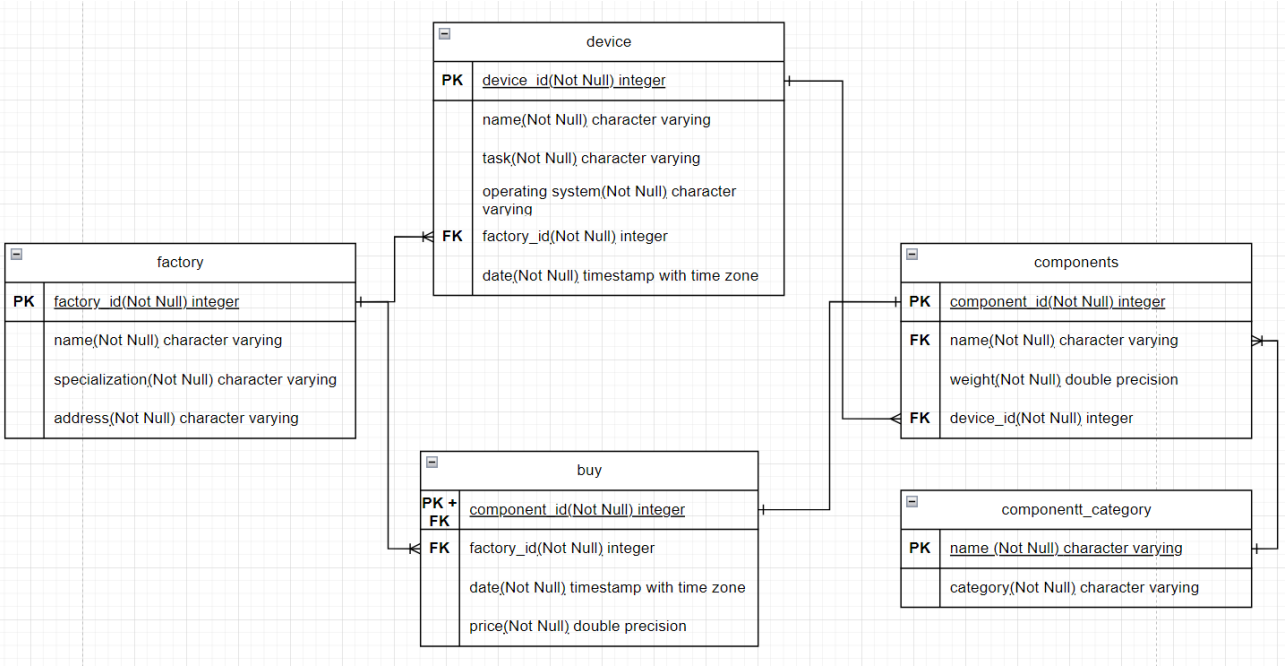
1. Перетворити модуль “Модель” з шаблону MVC РГР у вигляд об’єктно-реляційної проекції (ORM).
2. Створити та проаналізувати різні типи індексів у PostgreSQL.
3. Розробити тригер бази даних PostgreSQL.
4. Навести приклади та проаналізувати рівні ізоляції транзакцій у PostgreSQL.

Варіант 20

20	*GIN, BRIN*	*after insert, update*

Виконання роботи

Логічна модель (схема) “Система управління та аналізу даних в галузі робототехніки”



Класи ORM зі зв’язками

```
class Factory(Base):
    __tablename__ = "factory"

    factory_id = Column(Integer, primary_key=True, nullable=False)
    name = Column(String(30), nullable=False)
    specialization = Column(String(60), nullable=False)
    address = Column(String(70), unique=True, nullable=False)

    devices = relationship("Device", back_populates="factory")
    buys = relationship("Buy", back_populates="factory")

class Device(Base):
    __tablename__ = "device"

    device_id = Column(Integer, primary_key=True, nullable=False)
    name = Column(String(20), nullable=False)
    task = Column(String(200), nullable=False)
    operating_system = Column(String(20), nullable=False)
    factory_id = Column(Integer, ForeignKey('factory.factory_id'), nullable=False)
    date = Column(DateTime, nullable=False)

    factory = relationship("Factory", back_populates="devices")
    components = relationship("Components", back_populates="device")

class Components(Base):
    __tablename__ = "components"

    component_id = Column(Integer, primary_key=True, nullable=False)
    name = Column(String(20), ForeignKey('component_category.name'), nullable=False)
    weight = Column(DOUBLE_PRECISION, nullable=False)
    device_id = Column(Integer,  ForeignKey('device.device_id'))

    device = relationship("Device", back_populates="components")
    buys = relationship("Buy", back_populates="component")
    component_category = relationship("Component_Category",
back_populates="component")

class Component_Category(Base):
    __tablename__ = "component_category"

    name = Column(String(20), primary_key=True, nullable=False)
    category = Column(String(30), nullable=False)

    name = Column(String(20), primary_key=True, nullable=False)
    category = Column(String(30), nullable=False)

    component = relationship("Components", back_populates="component_category")

class Buy(Base):
    __tablename__ = "buy"

    component_id = Column(Integer, ForeignKey('components.component_id'),
primary_key=True, nullable=False)
    factory_id = Column(Integer, ForeignKey('factory.factory_id'), nullable=False)
    date = Column(DateTime, nullable=False)
    price = Column(DOUBLE_PRECISION, nullable=False)

    factory = relationship("Factory", back_populates="buys")
    component = relationship("Components", back_populates="buys")
```

Приклади запитів у вигляді ORM

Фрагмент програми для введення даних в таблицю:

```
def add_row(self, attributes, attributes_name, table):
    session = self.Session()

    table = Base.metadata.tables[table.lower()]

    new_row = {}
    for column_name, column_value in zip(attributes_name, attributes):
        if column_name in table.columns:
            new_row[column_name] = column_value

    session.execute(table.insert().values(new_row))
    session.commit()
```

Фрагмент програми для видалення даних з таблиці:

```
def delete_row(self, row_id, PK, table):
    session = self.Session()

    table = Base.metadata.tables[table.lower()]
    condition = getattr(table.c, PK) == row_id
    session.execute(table.delete().where(condition))


    session.commit()
```

Фрагмент програми для оновлення даних в таблиці:

```
def update_row(self, row_id, PK, attributes, attributes_name, table):
    session = self.Session()

    table = Base.metadata.tables[table.lower()]

    update_values = {}
    for column_name, column_value in zip(attributes_name, attributes):
        if column_name in table.columns:
            update_values[column_name] = column_value

    condition = getattr(table.c, PK) == row_id
    session.execute(table.update().where(condition).values(update_values))


    session.commit()
```

Фрагмент програми для генерування даних в таблиці:

```
def random_table(self, counts, table):
    session = self.Session()

    query = text(f"CALL random_{table.lower()}(:counts)")
    session.execute(query, {'counts': counts})

    session.commit()
```

Фрагмент програми для пошуку даних у таблиці:

```
def get_DeviceOfFactory(self, FK):
    session = self.Session()

    start_time = time.time()

    factory = session.query(Factory).filter_by(factory_id=FK).first()

    end_time = time.time()
    duration = (end_time - start_time) * 1000

    device_counts = {}
    for device in factory.devices:
        device_counts[device.name] = device_counts.get(device.name, 0) + 1

    rows = [
        (factory.factory_id, factory.name, factory.address, device_name, count)
        for device_name, count in device_counts.items()
    ]
    column_names = ["factory_id", "factory_name", "address", "device_name", "count"]
    return rows, column_names, duration

def get_ComponentsOfDevice(self, FK):
    session = self.Session()

    start_time = time.time()

    device = session.query(Device).filter_by(device_id=FK).first()

    end_time = time.time()
    duration = (end_time - start_time) * 1000

    component_averages = {}
    for component in device.components:
        if component.name not in component_averages:
            component_averages[component.name] = []
        component_averages[component.name].append(component.weight)

    rows = [
        (device.device_id, device.name, component_name, sum(weights) / len(weights))
        for component_name, weights in component_averages.items()
    ]
    column_names = ["device_id", "device_name", "component_name", "avg_weight"]
    return rows, column_names, duration

def get_BuyOfComponents(self, first_date, second_date, FK):
    session = self.Session()

    start_time = time.time()

    factory = session.query(Factory).filter_by(factory_id=FK).first()

    end_time = time.time()
    duration = (end_time - start_time) * 1000

    rows = [
        (factory.factory_id, factory.name, buy.component.component_id,
buy.component.name, buy.date, buy.price)
        for buy in factory.buys
        if first_date <= buy.date <= second_date
    ]
    column_names = ["factory_id", "factory_name", "component_id", "component_name",
"date", "price"]
    return rows, column_names, duration
```

Фрагмент програми для отримання імен стовпчиків таблиці:

```python
def get_attributes(self, table):
    return Base.metadata.tables[table.lower()].columns.keys()
```

Створення індексів

GIN

```
CREATE INDEX idx_gin_name ON components USING GIN (name gin_trgm_ops);
```

BRIN

```
CREATE INDEX idx_brin_name ON components USING BRIN(name)
```

Приклад 1: Просте фільтрування

Без індексів:

Query | Query History

```
1  SET enable_seqscan = on;
2  EXPLAIN ANALYSE
3  SELECT * FROM components
4  WHERE name LIKE '%r%'
5  LIMIT 15;
```

Data Output | Messages | Notifications

	QUERY PLAN text
1	Limit (cost=0.00..0.31 rows=15 width=30) (actual time=0.022..0.025 rows=15 loops=1)
2	-> Seq Scan on components (cost=0.00..228265.25 rows=11000100 width=30) (actual time=0.020..0.023 rows=15 loop...
3	Filter: ((name)::text ~~ '%r%'::text)
4	Planning Time: 0.218 ms
5	Execution Time: 0.045 ms

З індексом GIN:

Query Query History

```
1  SET enable_seqscan = off;
2  EXPLAIN ANALYSE
3  SELECT * FROM components
4  WHERE name LIKE '%r%'
5  LIMIT 15;
```

Data Output Messages Notifications

	QUERY PLAN text
1	Limit (cost=152106.41..152106.72 rows=15 width=30) (actual time=1388.610..1388.614 rows=15 loops=1)
2	-> Bitmap Heap Scan on components (cost=152106.41..380371.66 rows=11000100 width=30) (actual time=1388.609..1388.612 rows=15 loops=1)
3	Recheck Cond: ((name)::text ~~ '%r%'::text)
4	Heap Blocks: lossy=1
5	-> Bitmap Index Scan on idx_gin_name (cost=0.00..149356.39 rows=11000100 width=0) (actual time=1382.126..1382.126 rows=7017688 loop...
6	Index Cond: ((name)::text ~~ '%r%'::text)
7	Planning Time: 0.102 ms
8	Execution Time: 1389.185 ms

З індексом BRIN:

Query | Query History

```
1  SET enable_seqscan = off;
2
3  EXPLAIN ANALYSE
4  SELECT * FROM components
5  WHERE name LIKE '%r%'
6  LIMIT 15;
7
8
```

Data Output | Messages | Notifications

	QUERY PLAN text
1	Limit (cost=10000000000.00..10000000000.31 rows=15 width=30) (actual time=0.011..0.013 rows=15 loops=1)
2	-> Seq Scan on components (cost=10000000000.00..10000228265.25 rows=11000100 width=30) (actual time=0.010..0.012 rows=15 loop...
3	Filter: ((name)::text ~~ '%r%'::text)
4	Planning Time: 0.061 ms
5	Execution Time: 0.023 ms

Приклад 2: Агрегатні функції

Без індексів:

Query | Query History

```
1  SET enable_seqscan = on;
2
3  EXPLAIN ANALYSE
4  SELECT COUNT(*) FROM components
5  WHERE name = 'Servo motors 6'
```

	QUERY PLAN text
1	Finalize Aggregate (cost=149224.84..149224.85 rows=1 width=8) (actual time=327.836..331.498 rows=1 loops=1)
2	-> Gather (cost=149224.62..149224.84 rows=2 width=8) (actual time=327.756..331.492 rows=3 loops=1)
3	Workers Planned: 2
4	Workers Launched: 2
5	-> Partial Aggregate (cost=148224.62..148224.64 rows=1 width=8) (actual time=300.559..300.559 rows=1 loops=3)
6	-> Parallel Seq Scan on components (cost=0.00..148056.19 rows=67375 width=0) (actual time=0.226..298.027 rows=56452 loop...
7	Filter: ((name)::text = 'Servo motors 6'::text)
8	Rows Removed by Filter: 3610248
9	Planning Time: 0.636 ms
10	Execution Time: 331.517 ms

З індексом GIN:

Query | Query History

```
1  SET enable_seqscan = off;
2
3  EXPLAIN ANALYSE
4  SELECT COUNT(*) FROM components
5  WHERE name = 'Servo motors 6'
```

	QUERY PLAN text
1	Finalize Aggregate (cost=142820.76..142820.77 rows=1 width=8) (actual time=577.324..583.392 rows=1 loops=1)
2	-> Gather (cost=142820.55..142820.76 rows=2 width=8) (actual time=576.967..583.385 rows=3 loops=1)
3	Workers Planned: 2
4	Workers Launched: 2
5	-> Partial Aggregate (cost=141820.55..141820.56 rows=1 width=8) (actual time=548.293..548.293 rows=1 loops=3)
6	-> Parallel Bitmap Heap Scan on components (cost=12947.75..141652.11 rows=67375 width=0) (actual time=316.785..545.638 rows=56452 loop...
7	Recheck Cond: ((name)::text = 'Servo motors 6'::text)
8	Rows Removed by Index Recheck: 1311719
9	Heap Blocks: exact=16129 lossy=12259
10	-> Bitmap Index Scan on idx_gin_name (cost=0.00..12907.32 rows=161701 width=0) (actual time=340.092..340.092 rows=169355 loops=1)
11	Index Cond: ((name)::text = 'Servo motors 6'::text)
12	Planning Time: 0.120 ms
13	Execution Time: 583.519 ms

З індексом BRIN:

Query | Query History

```
1  SET enable_seqscan = off;
2
3  EXPLAIN ANALYSE
4  SELECT COUNT(*) FROM components
5  WHERE name = 'Servo motors 6'
```

	QUERY PLAN text
1	Finalize Aggregate (cost=140821.77..140821.78 rows=1 width=8) (actual time=423.344..429.456 rows=1 loops=1)
2	-> Gather (cost=140821.55..140821.76 rows=2 width=8) (actual time=423.253..429.451 rows=3 loops=1)
3	Workers Planned: 2
4	Workers Launched: 2
5	-> Partial Aggregate (cost=139821.55..139821.56 rows=1 width=8) (actual time=392.761..392.762 rows=1 loops=3)
6	-> Parallel Bitmap Heap Scan on components (cost=77.83..139653.12 rows=67375 width=0) (actual time=0.908..390.128 rows=56452 loop...
7	Recheck Cond: ((name)::text = 'Servo motors 6'::text)
8	Rows Removed by Index Recheck: 3610248
9	Heap Blocks: lossy=34005
10	-> Bitmap Index Scan on idx_brin_name (cost=0.00..37.40 rows=6489785 width=0) (actual time=2.582..2.582 rows=907640 loops=1)
11	Index Cond: ((name)::text = 'Servo motors 6'::text)
12	Planning Time: 0.106 ms
13	Execution Time: 429.488 ms

Приклад 3: Групування

Без індексів:

```
1  SET enable_seqscan = on;
2
3  EXPLAIN ANALYSE
4  SELECT name, device_id, COUNT(*) FROM components
5  WHERE name = 'Servo motors 6'
6  GROUP BY name, device_id
```

	QUERY PLAN text
5	Workers Launched: 2
6	-> Partial GroupAggregate (cost=153459.64..154638.70 rows=67375 width=26) (actual time=304.923..323.950 rows=55070 loops=3)
7	Group Key: device_id
8	-> Sort (cost=153459.64..153628.07 rows=67375 width=18) (actual time=304.915..310.887 rows=56452 loops=3)
9	Sort Key: device_id
10	Sort Method: external merge Disk: 1704kB
11	Worker 0: Sort Method: quicksort Memory: 3920kB
12	Worker 1: Sort Method: quicksort Memory: 3953kB
13	-> Parallel Seq Scan on components (cost=0.00..148056.19 rows=67375 width=18) (actual time=0.252..289.955 rows=56452 loop...
14	Filter: ((name)::text = 'Servo motors 6'::text)
15	Rows Removed by Filter: 3610248
16	Planning Time: 0.095 ms
17	Execution Time: 410.371 ms

З індексом GIN:

```
1  SET enable_seqscan = off;
2
3  EXPLAIN ANALYSE
4  SELECT name, device_id, COUNT(*) FROM components
5  WHERE name = 'Servo motors 6'
6  GROUP BY name, device_id
```

-> Sort (cost=147055.56..147224.00 rows=67375 width=18) (actual time=575.162..580.277 rows=56452 loops=3)
Sort Key: device_id
Sort Method: external merge Disk: 1704kB
Worker 0: Sort Method: quicksort Memory: 3916kB
Worker 1: Sort Method: quicksort Memory: 3955kB
-> Parallel Bitmap Heap Scan on components (cost=12947.75..141652.11 rows=67375 width=18) (actual time=328.803..562.188 rows=56452 loo...
Recheck Cond: ((name)::text = 'Servo motors 6'::text)
Rows Removed by Index Recheck: 1311719
Heap Blocks: exact=14965 lossy=12185
-> Bitmap Index Scan on idx_gin_name (cost=0.00..12907.32 rows=161701 width=0) (actual time=351.406..351.406 rows=169355 loops=1)
Index Cond: ((name)::text = 'Servo motors 6'::text)
Planning Time: 0.783 ms
Execution Time: 670.091 ms

З індексом BRIN:

```
SET enable_seqscan = off;

EXPLAIN ANALYSE
SELECT name, device_id, COUNT(*) FROM components
WHERE name = 'Servo motors 6'
GROUP BY name, device_id
```

```
-> Sort  (cost=145056.57..145225.00 rows=67375 width=18) (actual time=428.104..433.298 rows=56452 loops=3)
    Sort Key: device_id
    Sort Method: external merge  Disk: 1752kB
    Worker 0:  Sort Method: quicksort  Memory: 3881kB
    Worker 1:  Sort Method: quicksort  Memory: 3901kB
    -> Parallel Bitmap Heap Scan on components  (cost=77.83..139653.12 rows=67375 width=18) (actual time=0.968..414.598 rows=56452 loop.
        Recheck Cond: ((name)::text = 'Servo motors 6'::text)
        Rows Removed by Index Recheck: 3610248
        Heap Blocks: lossy=33132
        -> Bitmap Index Scan on idx_brin_name  (cost=0.00..37.40 rows=6489785 width=0) (actual time=2.777..2.777 rows=907640 loops=1)
            Index Cond: ((name)::text = 'Servo motors 6'::text)
Planning Time: 0.150 ms
Execution Time: 527.151 ms
```

Приклад 4: Сортування

Без індексів:

```
SET enable_seqscan = on;

EXPLAIN ANALYSE
SELECT * FROM components
WHERE name = 'Servo motors 6'
ORDER BY device_id

```

```
-> Parallel Seq Scan on components  (cost=0.00..148056.19 rows=67375 width=30) (actual time=0.211..317.074 rows=56452 loop...
    Filter: ((name)::text = 'Servo motors 6'::text)
    Rows Removed by Filter: 3610248
Planning Time: 0.538 ms
Execution Time: 395.369 ms
```

З індексом GIN:

```
SET enable_seqscan = off;

EXPLAIN ANALYSE
SELECT * FROM components
WHERE name = 'Servo motors 6'
ORDER BY device_id
```

```
Rows Removed by Index Recheck: 1311719
Heap Blocks: exact=16923 lossy=12079
-> Bitmap Index Scan on idx_gin_name  (cost=0.00..12907.32 rows=161701 width=0) (actual time=335.421..335.422 rows=169355 loops=1)
    Index Cond: ((name)::text = 'Servo motors 6'::text)
Planning Time: 0.131 ms
Execution Time: 646.622 ms
```

З індексом BRIN:

```
SET enable_seqscan = off;

EXPLAIN ANALYSE
SELECT * FROM components
WHERE name = 'Servo motors 6'
ORDER BY device_id
```

```
-> Parallel Bitmap Heap Scan on components  (cost=77.83..139653.12 rows=67375 width=30) (actual time=1.029..394.168 rows=56452 loop...
    Recheck Cond: ((name)::text = 'Servo motors 6'::text)
    Rows Removed by Index Recheck: 3610248
    Heap Blocks: lossy=33399
    -> Bitmap Index Scan on idx_brin_name  (cost=0.00..37.40 rows=6489785 width=0) (actual time=2.921..2.922 rows=907640 loops=1)
        Index Cond: ((name)::text = 'Servo motors 6'::text)
Planning Time: 0.126 ms
Execution Time: 484.010 ms
```

Приклад 5: Операції з'єднання

Без індексів:

```
SET enable_seqscan = on;

EXPLAIN ANALYSE
SELECT c.component_id, c.name, c.device_id, COUNT(*) FROM components c
JOIN device d ON c.device_id = d.device_id
WHERE c.name = 'Servo motors 6'
GROUP BY c.component_id
```

```
-> Parallel Hash  (cost=148056.19..148056.19 rows=67375 width=22) (actual time=313.898..313.898 rows=56452 loops=3)
    Buckets: 262144  Batches: 1  Memory Usage: 11360kB
    -> Parallel Seq Scan on components c  (cost=0.00..148056.19 rows=67375 width=22) (actual time=0.201..300.520 rows=56452 loops=3)
        Filter: ((name)::text = 'Servo motors 6'::text)
        Rows Removed by Filter: 3610248
Planning Time: 2.375 ms
Execution Time: 588.678 ms
```

З індексом GIN:

```
SET enable_seqscan = off;

EXPLAIN ANALYSE
SELECT c.component_id, c.name, c.device_id, COUNT(*) FROM components c
JOIN device d ON c.device_id = d.device_id
WHERE c.name = 'Servo motors 6'
GROUP BY c.component_id
```

```
19                  -> Parallel Bitmap Heap Scan on components c  (cost=12947.75..141652.11 rows=67375 width=22) (actual time=316.120..578.114 rows=56452 loo...
20                      Recheck Cond: ((name)::text = 'Servo motors 6'::text)
21                      Rows Removed by Index Recheck: 1311719
22                      Heap Blocks: exact=16105 lossy=12365
23                      -> Bitmap Index Scan on idx_gin_name  (cost=0.00..12907.32 rows=161701 width=0) (actual time=341.849..341.849 rows=169355 loops=1)
24                          Index Cond: ((name)::text = 'Servo motors 6'::text)
25  Planning Time: 0.290 ms
26  Execution Time: 788.486 ms
```

З індексом BRIN:

```sql
SET enable_seqscan = off;

EXPLAIN ANALYSE
SELECT c.component_id, c.name, c.device_id, COUNT(*) FROM components c
JOIN device d ON c.device_id = d.device_id
WHERE c.name = 'Servo motors 6'
GROUP BY c.component_id
```

```
20                      Recheck Cond: ((name)::text = 'Servo motors 6'::text)
21                      Rows Removed by Index Recheck: 3610248
22                      Heap Blocks: lossy=33692
23                      -> Bitmap Index Scan on idx_brin_name  (cost=0.00..37.40 rows=6489785 width=0) (actual time=2.195..2.195 rows=907640 loops=1)
24                          Index Cond: ((name)::text = 'Servo motors 6'::text)
25  Planning Time: 0.183 ms
26  Execution Time: 599.479 ms
```

Результати:

Виконання запитів без індексів у всіх приклад виявилися швидшими чим з індексами GIN і BRIN. А з індексом BRIN запити трохи швидше виконалися чим з GIN. Такі результати виникли оскільки запити із Seq Scan ефективні, коли в результаті є велика кількість рядків, які підходять під задану умову. З індексом GIN запит виконується довше за Seq Scan і BRIN, оскільки багато рядків підходять під умову. GIN є ефективним для складних умов, за якими знаходяться невелика кількість рядків. BRIN призначений для колонок з лінійною залежністю, але він виявився ефективнішим за GIN.

Розробка тригерів

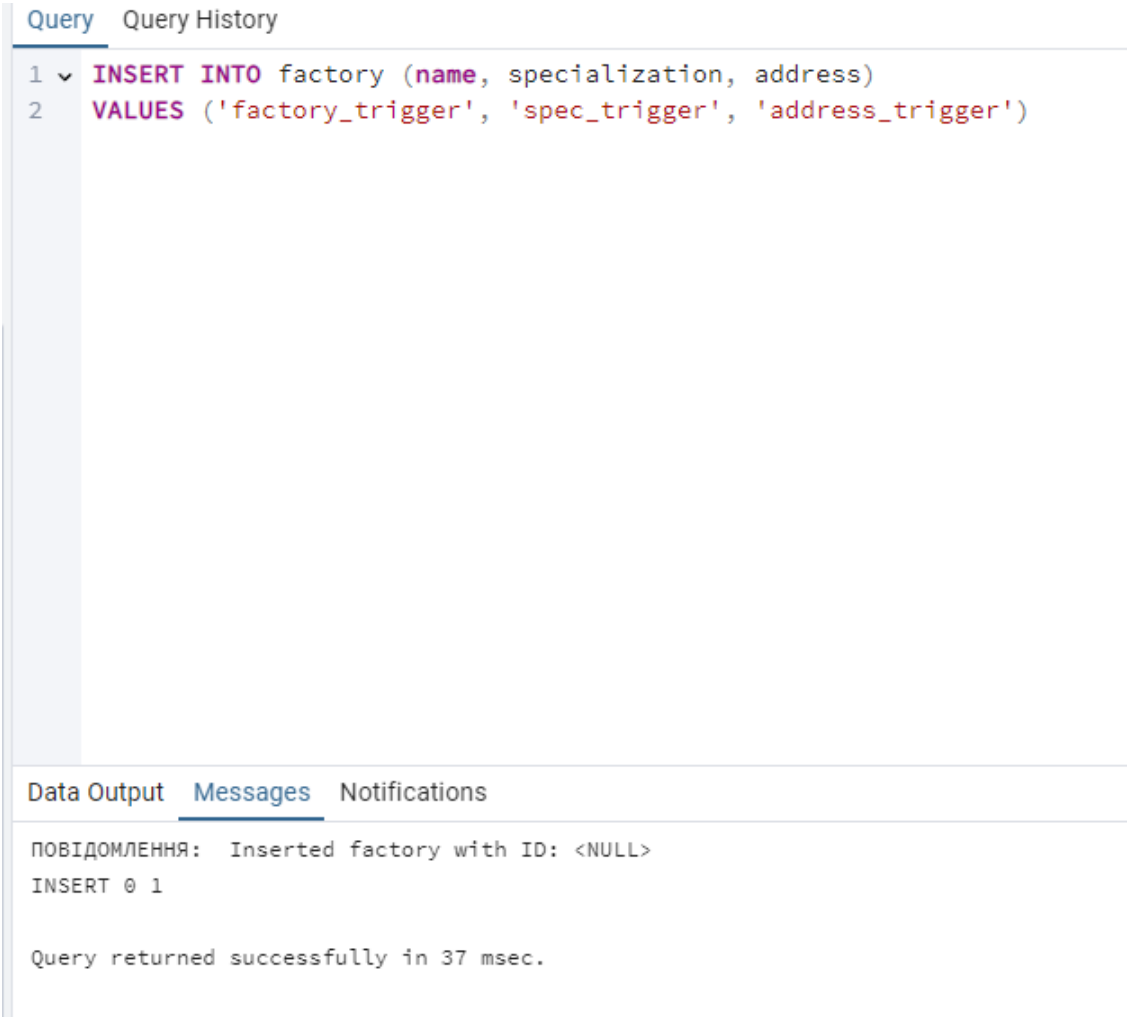
Створення функції для тригера:

```
CREATE OR REPLACE FUNCTION insert_update_trigger()
RETURNS TRIGGER AS $$
BEGIN
	IF TG_OP = 'INSERT' THEN
		RAISE NOTICE 'Inserted factory with ID: %', OLD.factory_id;
	ELSIF TG_OP = 'UPDATE' THEN
		RAISE NOTICE 'Updated factory with ID: %', NEW.factory_id;
	END IF;

	RETURN NEW;
EXCEPTION
	WHEN OTHERS THEN
		RAISE NOTICE 'An error occurred in insert_update_trigger trigger: %s',
SQLERRM;
		RETURN NULL;
END;
$$ LANGUAGE plpgsql;
```

Створення тригера для таблиці фабрика:

```
CREATE TRIGGER insert_update_trigger_t
AFTER INSERT OR UPDATE ON factory
FOR EACH ROW
EXECUTE FUNCTION insert_update_trigger();
```

Додавання рядка в таблицю фабрика:



Звідси видно, що тригер спрацював, оскільки вивелося повідомлення про вставку.

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	1	Boston Dynamics	industrial robots for assembly and processing	Address 10
2	2	ABB Robotics	mobile robots with advanced maneuvering capabilities	Address 2
3	3	Boston Dynamics	industrial robots for assembly and processing	Address 1
4	4	Boston Dynamics	industrial robots for assembly and processing	Address 0
5	6	KUKA Robotics	industrial robots for automation of production process...	Address 5
6	7	ABB Robotics	industrial robots for automation of production process...	Address 3
7	10	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 7
8	13	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 6
9	15	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 9
10	25	ABB Robotics	industrial robots for assembly and processing	Address 4
11	27	factory_trigger	spec_trigger	address_trigger

Зміна рядка в таблиці фабрика:

Query Query History

```
1  UPDATE factory
2  SET name = 'newvalue_factory',
3      specialization = 'newvalue_spec',
4      address = 'newvalue_address'
5  WHERE factory_id = 27;
```

Data Output Messages Notifications

```
ПОВІДОМЛЕННЯ:  Updated factory with ID: 27
UPDATE 1

Query returned successfully in 34 msec.
```

Звідси видно, що тригер спрацював, оскільки вивелося повідомлення про зміну.

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	1	Boston Dynamics	industrial robots for assembly and processing	Address 10
2	2	ABB Robotics	mobile robots with advanced maneuvering capabilities	Address 2
3	3	Boston Dynamics	industrial robots for assembly and processing	Address 1
4	4	Boston Dynamics	industrial robots for assembly and processing	Address 0
5	6	KUKA Robotics	industrial robots for automation of production process...	Address 5
6	7	ABB Robotics	industrial robots for automation of production process...	Address 3
7	10	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 7
8	13	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 6
9	15	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 9
10	25	ABB Robotics	industrial robots for assembly and processing	Address 4
11	27	newvalue_factory	newvalue_spec	newvalue_address

Використання рівнів ізоляції

READ COMMITTED

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	1	Boston Dynamics	industrial robots for assembly and processing	Address 10
2	2	ABB Robotics	mobile robots with advanced maneuvering capabilities	Address 2
3	3	Boston Dynamics	industrial robots for assembly and processing	Address 1
4	4	Boston Dynamics	industrial robots for assembly and processing	Address 0
5	6	KUKA Robotics	industrial robots for automation of production process...	Address 5
6	7	ABB Robotics	industrial robots for automation of production process...	Address 3
7	10	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 7
8	13	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 6
9	15	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 9
10	25	ABB Robotics	industrial robots for assembly and processing	Address 4
11	27	newvalue_factory	newvalue_spec	newvalue_address
12	28	name5	spec6	adrs5

Вікно 1:

```
SET TRANSACTION ISOLATION LEVEL READ COMMITTED;

BEGIN;

UPDATE factory SET name = 'AAAA' WHERE factory_id = 28;


```

```
ПОВІДОМЛЕННЯ:  Updated factory with ID: 28
UPDATE 1

Query returned successfully in 34 msec.
```

Вікно 2:

Query | Query History

```
SET TRANSACTION ISOLATION LEVEL READ COMMITTED;

BEGIN;

SELECT * FROM factory WHERE factory_id = 28;


```

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	28	name5	spec6	adrs5

Звідси видно, що без фіксації змін у першому вікні, у другому вікні немає змін і назва фабрики лишилося таким самим.

Вікно 1:

Query | Query History

```
SET TRANSACTION ISOLATION LEVEL READ COMMITTED;

COMMIT;


```

```
COMMIT

Query returned successfully in 35 msec.
```

Вікно 2:

```
1  SET TRANSACTION ISOLATION LEVEL READ COMMITTED;
2
3
4
5  SELECT * FROM factory WHERE factory_id = 28;
6
```

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	28	AAAA	spec6	adrs5

Тепер видно, що після фіксації у першому вікні, у другому вікні відображаються зміни, назва фабрики змінилася.

REPEATABLE READ

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	1	Boston Dynamics	industrial robots for assembly and processing	Address 10
2	2	ABB Robotics	mobile robots with advanced maneuvering capabilities	Address 2
3	3	Boston Dynamics	industrial robots for assembly and processing	Address 1
4	4	Boston Dynamics	industrial robots for assembly and processing	Address 0
5	6	KUKA Robotics	industrial robots for automation of production process...	Address 5
6	7	ABB Robotics	industrial robots for automation of production process...	Address 3
7	10	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 7
8	13	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 6
9	15	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 9
10	25	ABB Robotics	industrial robots for assembly and processing	Address 4
11	27	newvalue_factory	newvalue_spec	newvalue_address
12	28	BBBB	spec6	adrs5

Вікно 1:

```
1  SET TRANSACTION ISOLATION LEVEL REPEATABLE READ;
2
3
4  BEGIN;
5
6  SELECT * FROM factory WHERE factory_id = 28;
```

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	28	BBBB	spec6	adrs5

Вікно 2:

```
3   BEGIN;
4
5   UPDATE factory SET name = 'CCCCC' WHERE factory_id = 28;
6
7   COMMIT;
8
```

```
ПОВІДОМЛЕННЯ:  Updated factory with ID: 28
COMMIT

Query returned successfully in 34 msec.
```

Змінюємо таблицю з фіксацією

Вікно 1:

```
6   SELECT * FROM factory WHERE factory_id = 28;
7
8   COMMIT;
```

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	28	BBBB	spec6	adrs5

Видно, що навіть після фіксації змін у другому вікні, у першому вікні не відображаються зміни.

SERIALIZABLE

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	1	Boston Dynamics	industrial robots for assembly and processing	Address 10
2	2	ABB Robotics	mobile robots with advanced maneuvering capabilities	Address 2
3	3	Boston Dynamics	industrial robots for assembly and processing	Address 1
4	4	Boston Dynamics	industrial robots for assembly and processing	Address 0
5	6	KUKA Robotics	industrial robots for automation of production process...	Address 5
6	7	ABB Robotics	industrial robots for automation of production process...	Address 3
7	10	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 7
8	13	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 6
9	15	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 9
10	25	ABB Robotics	industrial robots for assembly and processing	Address 4
11	27	newvalue_factory	newvalue_spec	newvalue_address
12	29	ser_factory	ser_spec	ser_address

Вікно 1:

```
1  SET TRANSACTION ISOLATION LEVEL SERIALIZABLE;
2
3
4  BEGIN;
5
6  DELETE FROM factory WHERE factory_id = 29;
7
```

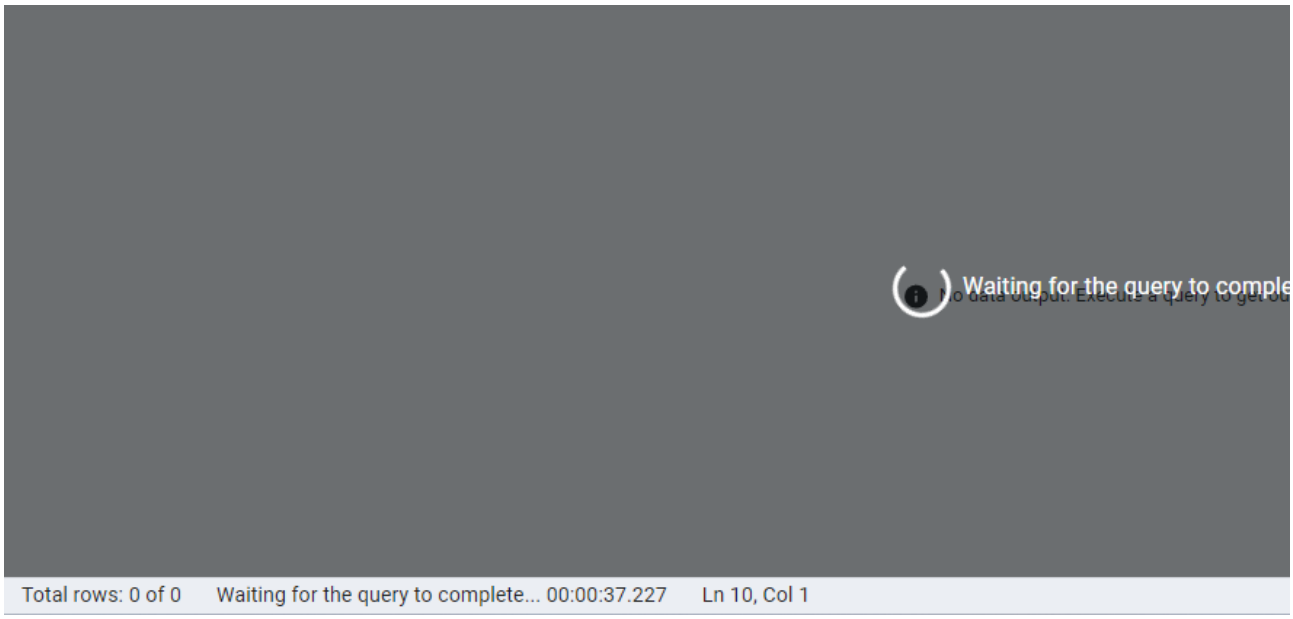
```
DELETE 1

Query returned successfully in 212 msec.
```

Видаляємо рядок без фіксації зміни.

Вікно 2:

Query | Query History

```
1  SET TRANSACTION ISOLATION LEVEL SERIALIZABLE;
2
3
4  BEGIN;
5
6  INSERT INTO factory (name, specialization, address)
7  VALUES ('ser_factory', 'ser_spec', 'ser_address');
8
9  COMMIT;
10
```



Як видно без фіксації зміни у першому вікні, у другому вікні запит не може виконатися.

Вікно 1:

```
8   COMMIT;
```

```
COMMIT

Query returned successfully in 34 msec.
```

Робимо фіксацію зміни.

Вікно 2:

```
ПОВІДОМЛЕННЯ:  Inserted factory with ID: <NULL>
COMMIT

Query returned successfully in 1 min 18 secs.
```

	factory_id [PK] integer	name character varying (30)	specialization character varying (60)	address character varying (70)
1	1	Boston Dynamics	industrial robots for assembly and processing	Address 10
2	2	ABB Robotics	mobile robots with advanced maneuvering capabilities	Address 2
3	3	Boston Dynamics	industrial robots for assembly and processing	Address 1
4	4	Boston Dynamics	industrial robots for assembly and processing	Address 0
5	6	KUKA Robotics	industrial robots for automation of production process...	Address 5
6	7	ABB Robotics	industrial robots for automation of production process...	Address 3
7	10	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 7
8	13	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 6
9	15	Boston Dynamics	mobile robots with advanced maneuvering capabilities	Address 9
10	25	ABB Robotics	industrial robots for assembly and processing	Address 4
11	27	newvalue_factory	newvalue_spec	newvalue_address
12	31	ser_factory	ser_spec	ser_address

Тепер у другому вікні запит зміг виконатися, оскільки відбулася фіксація змін у першому вікні.