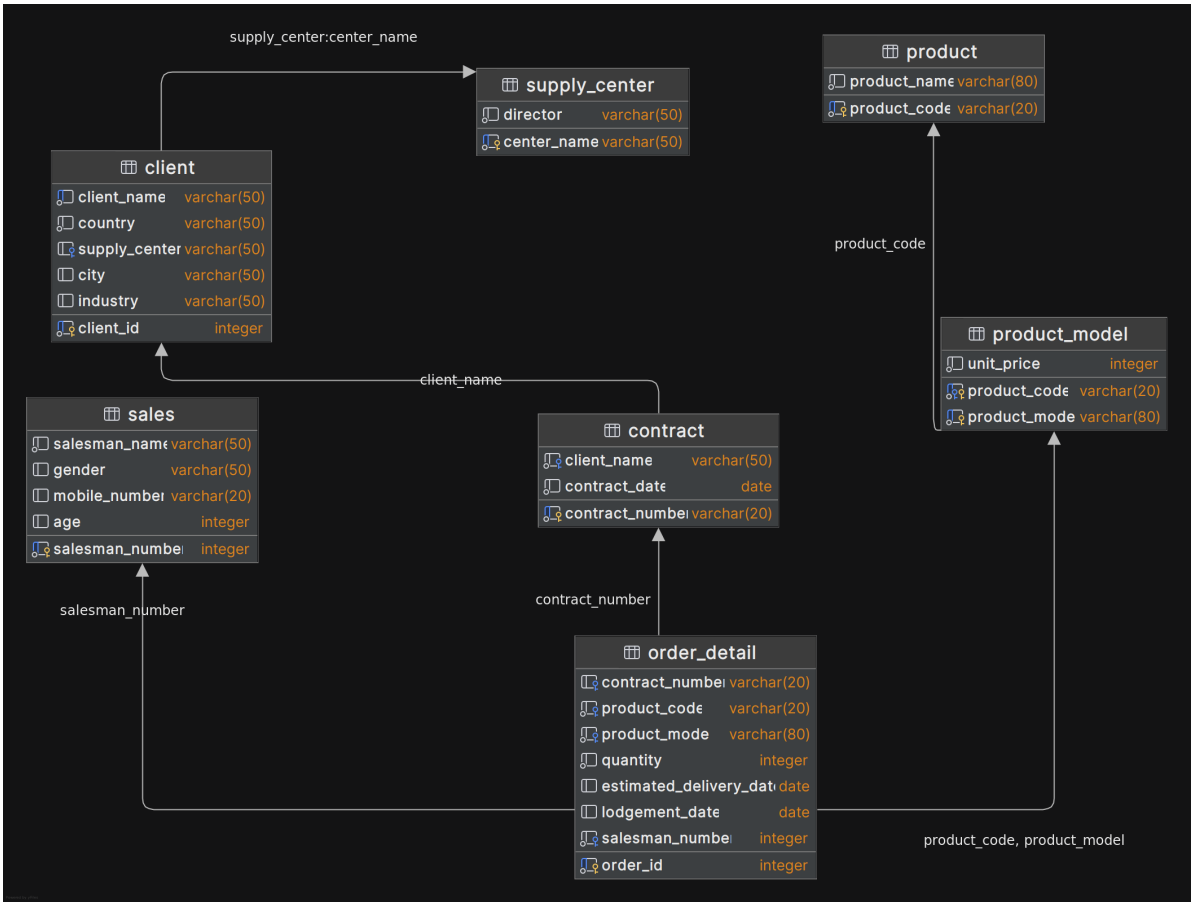
Spring 2025 CS307 Project1

OurTeam

魏国新 SID 12312030	姚圣淇 SID 12411126
Task: Python script C++ script write paper	Task: Design E-R Diagram Java script write paper
Percentage of contribution: 50%	Percentage of contribution: 50%

E-R diagram



- The E-R diagram is drawn on the processon

Database Design

(create table statements file is in `/create_table.sql`)

Content Description

1. supply_center

- **Purpose**: Stores information about supply centers.
- **Columns**:
  - `center_name` (Primary Key): Unique name of the supply center.
  - `director`: Name of the director managing the center.

2. `client`

- **Purpose**: Stores client details and their associated supply centers.
- **Columns**:
  - `client_id` (PK): Auto-incremented unique identifier for the client.
  - `client_name`: Unique name of the client.
  - `country`, `city`, `industry`: Geographic and business details of the client.
  - `supply_center` (Foreign Key): Links the client to their assigned supply center, which is defined by clients country.

3. `contract`

- **Purpose**: Stores contracts basic info.
- **Columns**:
  - `contract_number` (PK): Unique identifier for the contract.
  - `client_name` (Foreign Key): References the client who signed the contract.
  - `contract_date`: Date when the contract was signed.

4. `sales`

- **Purpose**: Stores salesman details.
- **Columns**:
  - `salesman_number` (PK): Unique identifier for the salesman.
  - `salesman_name`: Name of the salesperson.
  - `gender`, `age`, `mobile_number`: Basic information of the salesman.

5. `product`

- **Purpose**: Stores basic product information.
- **Columns**:
  - `product_code` (PK): Unique code for the product.
  - `product_name`: Descriptive name of the product.

6. `product_model`

- **Purpose**: Stores specific models of a product and their unit price.
- **Columns**:
  - `product_code` (PK/FK): Links to the parent product (`product.product_code`).
  - `product_model` (PK): Name of the model (e.g., "Pro Max 256GB").

- `unit_price`: Price per unit for the model.

7. `order_detail`

- **Purpose**: Captures detailed information about individual orders.
- **Columns**:
  - `order_id` (PK): Auto-incremented unique identifier for the order.
  - `contract_number` (FK): Links the order to its parent contract.
  - `product_code` + `product_model` (Composite FK): Specifies the product model ordered.
  - `quantity`: Number of units ordered.
  - `estimated_delivery_date`: Planned delivery date.
  - `lodgement_date`: Actual delivery date.
  - `salesman_number` (FK): Salesperson responsible for the order.

Data Import

Java

in `src/javaImplementation`

Script name	Author	Description
/Java/Load.java	Yao Shengqi	The main function. Run this with parameters
/Java/LowLoad.java	Yao Shengqi	The class that imports the data in serial
/Java/ConcurrentLoad.java	Yao Shengqi	The class that imports the data concurrently
/Java/PrepareTool.java	Yao Shengqi	The class that provides preparing method

How to use

1. Import all the .jar file in `/dependencies`. Notice the postgresql dependency is not included.
2. Use `create_table.sql` to create table.
3. Modify the `resources/dbUser.properties`. Edit the 'database', 'user', 'pwd', 'port'
4. Move the original (or modified) .csv file under path `/resources`. Rename the file `output25S.csv`
5. Open `/src/Java/Load.java`, run with parameters:
   1. `0` concurrent mode
   2. `1` serial mode

Python

in `src/Python`

Script name	Author	Description
load_single.py	Wei Guoxin	Import data by insert them in turn
load_parallel.py	Wei Guoxin	A parallel version of the above code
load_imp_single.py	Wei Guoxin	Optimized version of import data
load_imp_par.py	Wei Guoxin	A parallel version of the above code

How to use

1. Use conda to create a environment `database`
2. Use pip to get psycopg2 and pandas
3. run the selected script

C++

in `src/C++`

Script name	Author	Description
load_single.cpp	Wei Guoxin	Import data by insert them in turn
load_parallel.cpp	Wei Guoxin	A parallel version of the above code
load_imp_sin.cpp	Wei Guoxin	Optimized version of import data
load_imp_par.cpp	Wei Guoxin	A parallel version of the above code

How to use

1. Read `env.txt` and configure the environment
2. use cmake and make to create executable file
3. run the code to import data

Advanced

Optimization

Java

- In concurrent mode, the script first parses the data and stores it into a list. It then imports the data in three concurrent batches based on parent-child table relationships. Each batch is mutually independent, allowing concurrent imports. Lower-level data depends on the completion of higher-level data. The third batch exclusively imports the order_details table by splitting the list into multiple sub-batches for multi-threaded import.

Python

- **Batch insertion** is achieved through `execute_batch` and **temporary tables**, combining multiple records into a single batch to reduce database interaction overhead.
- When reading the CSV file, the `dtype` parameter is used to explicitly specify column types (e.g., strings, numeric values), avoiding the performance cost of Pandas' automatic type inference.

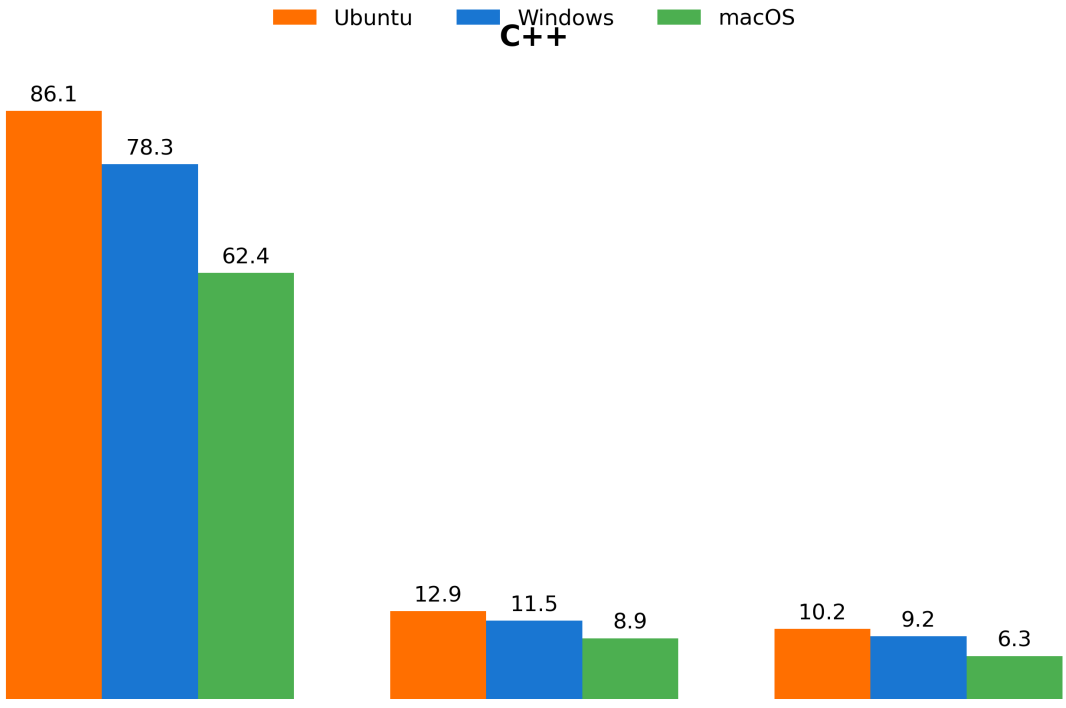
- **Thread pool technology** is employed for parallel optimization, significantly improving code execution speed.

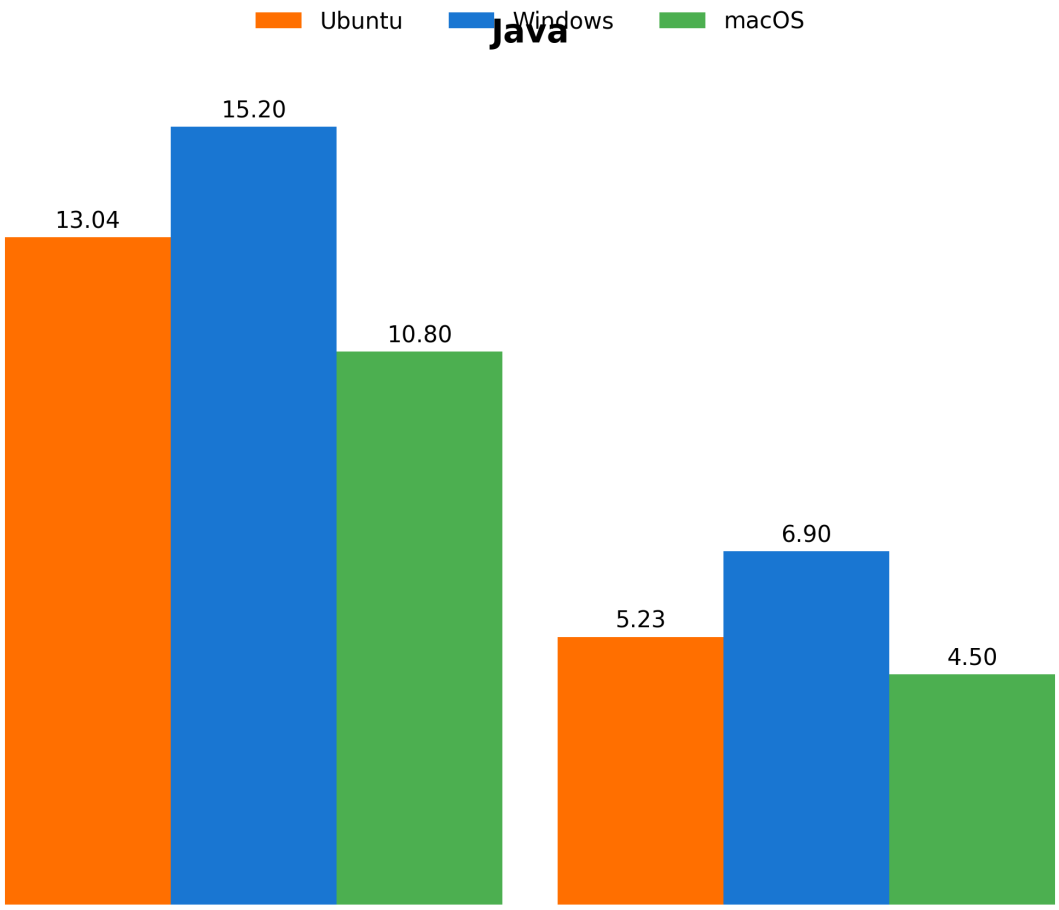
C++

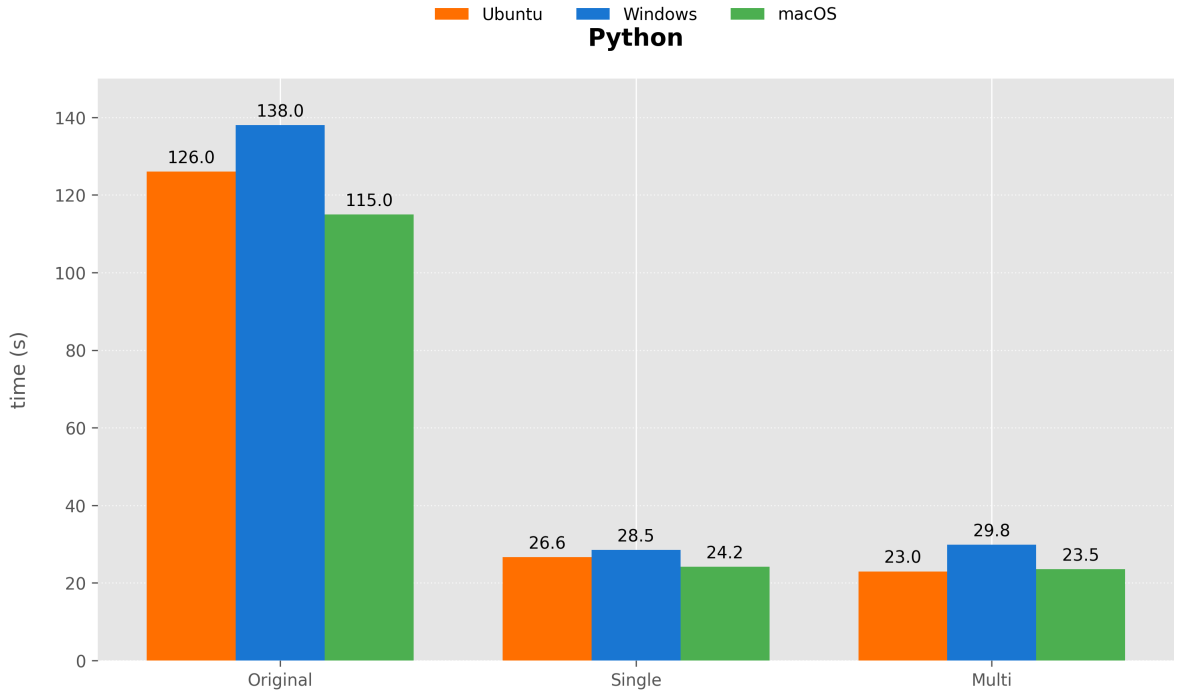
- Uses `std::async` and `std::future` to implement multi-threaded parallel insertion of data into different tables
- Uses `pqxx::stream_to` for batch streaming insertion instead of executing SQL statements row by row, reducing database round trips and significantly improving insertion efficiency
- Uses pass-by-reference to avoid data copying (`std::ref`)

Compared different scripts in different system

		Ubuntu 22.04	Windows 11	macOS
Java	single-thread	13.037	15.2	10.8
	multithreading	5.231	6.9	4.5
Python	original version	126.0	138.0	115.0
	single-thread	26.63	28.5	24.2
	multithreading	22.97	29.8	23.5
C++	original version	86.1	78.3	62.4
	single-thread	12.87	11.5	8.9
	multithreading	10.24	9.2	6.3

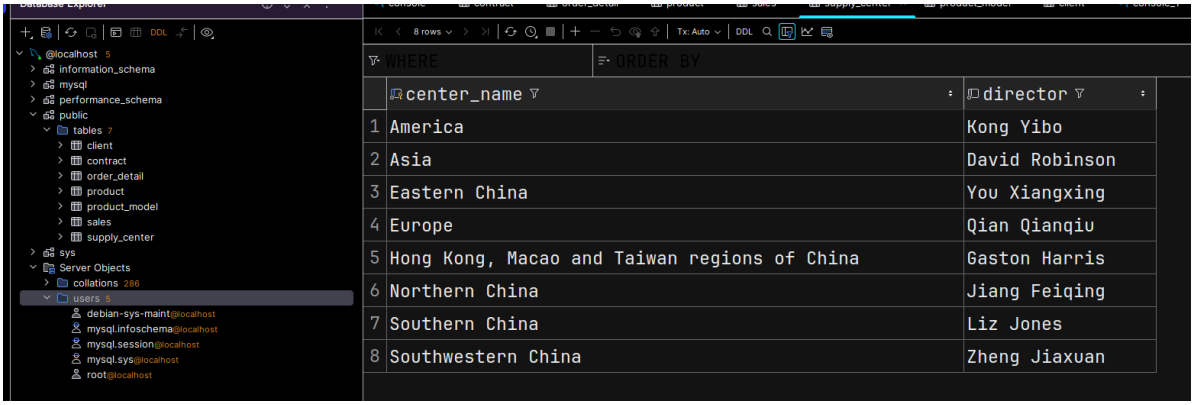






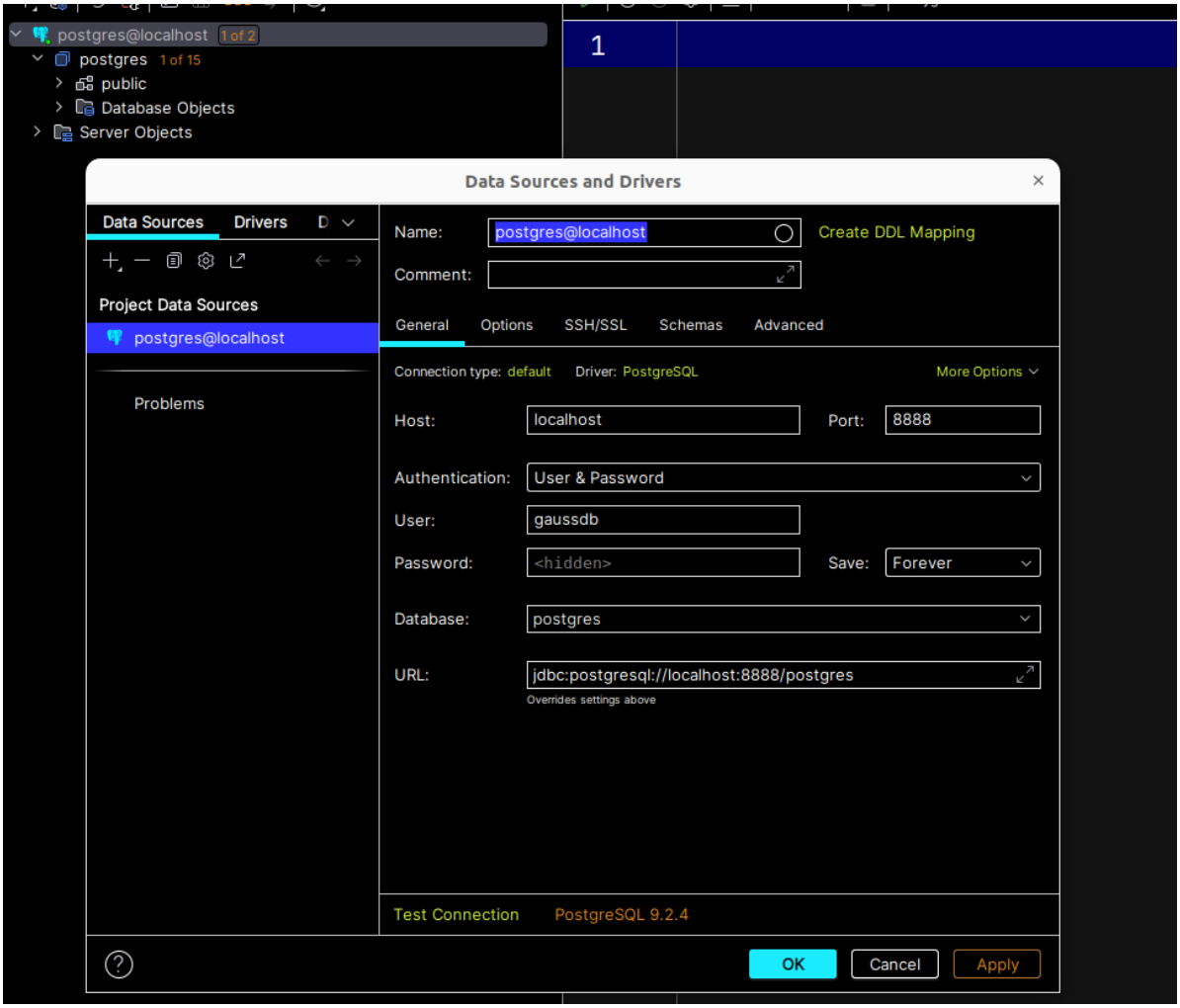
other databases

Mysql



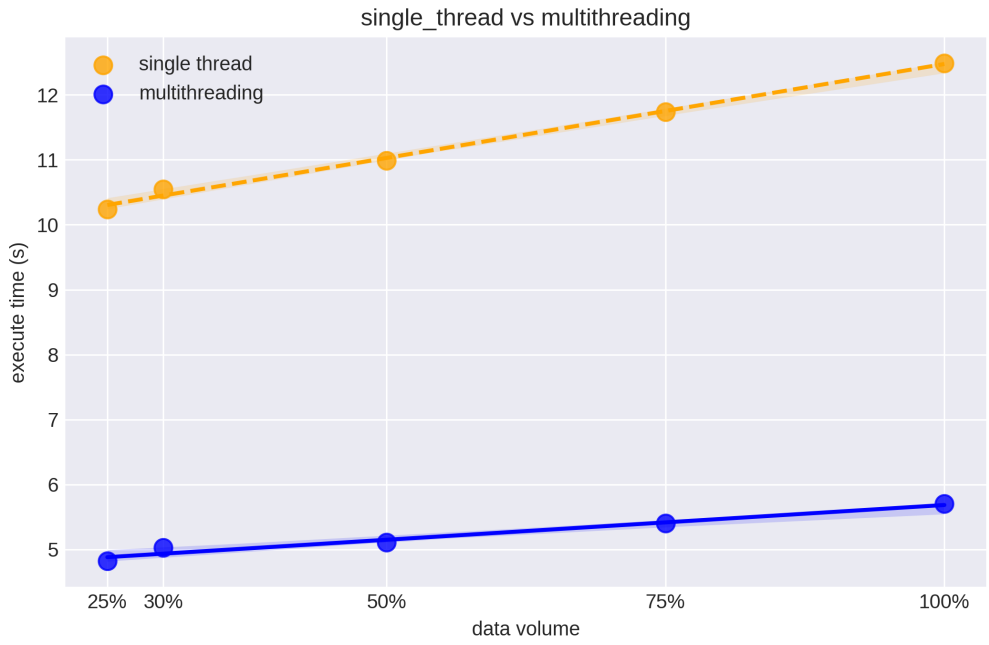
	center_name	director
1	America	Kong Yibo
2	Asia	David Robinson
3	Eastern China	You Xiangxing
4	Europe	Qian Qianqiu
5	Hong Kong, Macao and Taiwan regions of China	Gaston Harris
6	Northern China	Jiang Feiqing
7	Southern China	Liz Jones
8	Southwestern China	Zheng Jiaxuan

OpenGauss



import data with different data volumes

data volume	single-thread time(s)	multithreading time(s)
25%	10.24	4.82
30%	10.55	5.03
50%	10.99	5.11
75%	11.74	5.40
100%	12.49	5.70


single_thread vs multithreading
single thread
multithreading
execute time (s)
12
11
10
9
8
7
6
5
25%
30%
50%
75%
100%
data volume