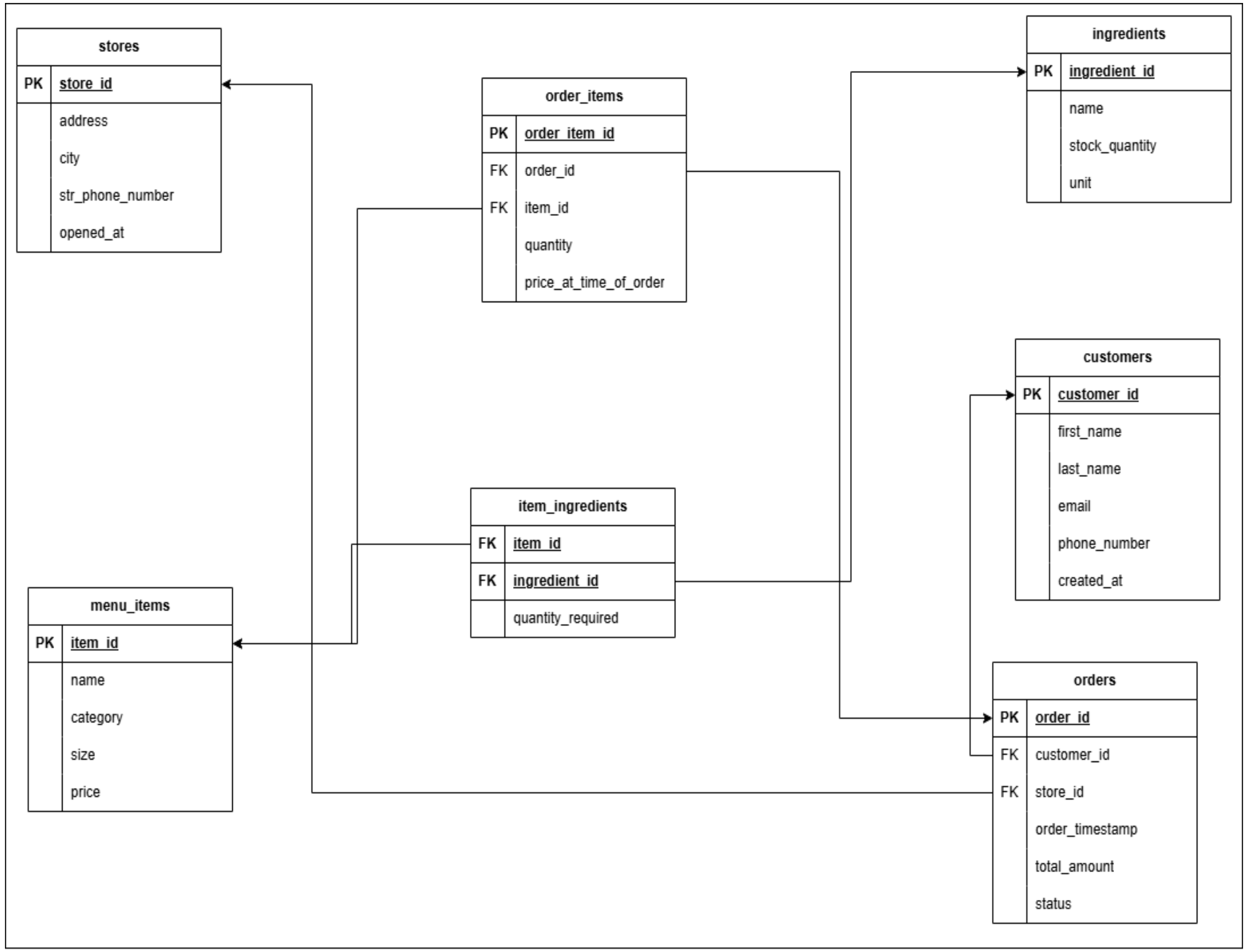
Capstone Project: Designing RushMore Pizzeria's Enterprise Database system

Objective: Design, deploy and populate a production-ready PostgreSQL database in the cloud.

Design & Deploy

Phase 1: Data Modelling

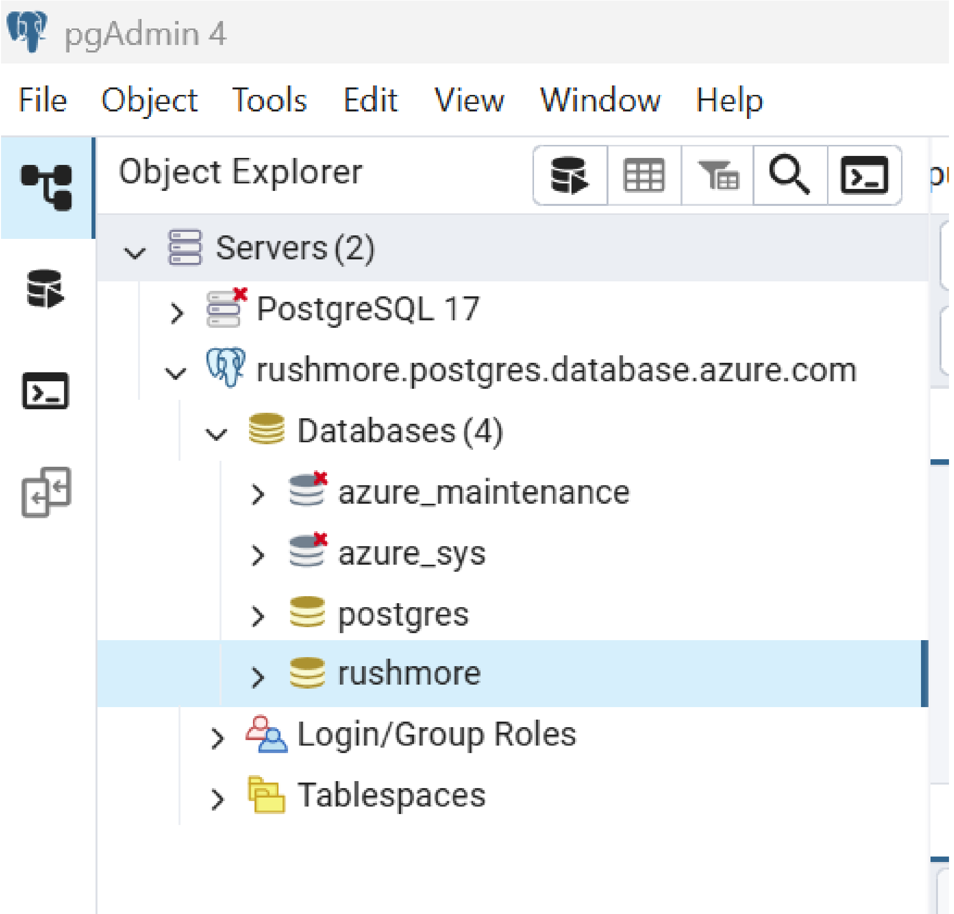
Here we had a design of a 3NF which the core idea is to organize data in our database with minimal redundancy and optimal data integrity by eliminating transitive dependencies(where non key attribute solely dependent directly on a primary key). From our project we had 7 tables to model and create a structured blueprint that would define and organize our data. I used DRAW.IO for my Entity relationship diagram to visually represent data points, their relationships, and how they can be grouped and stored to ensure data quality, consistency, and efficient access for analysis.



Design and Deployment

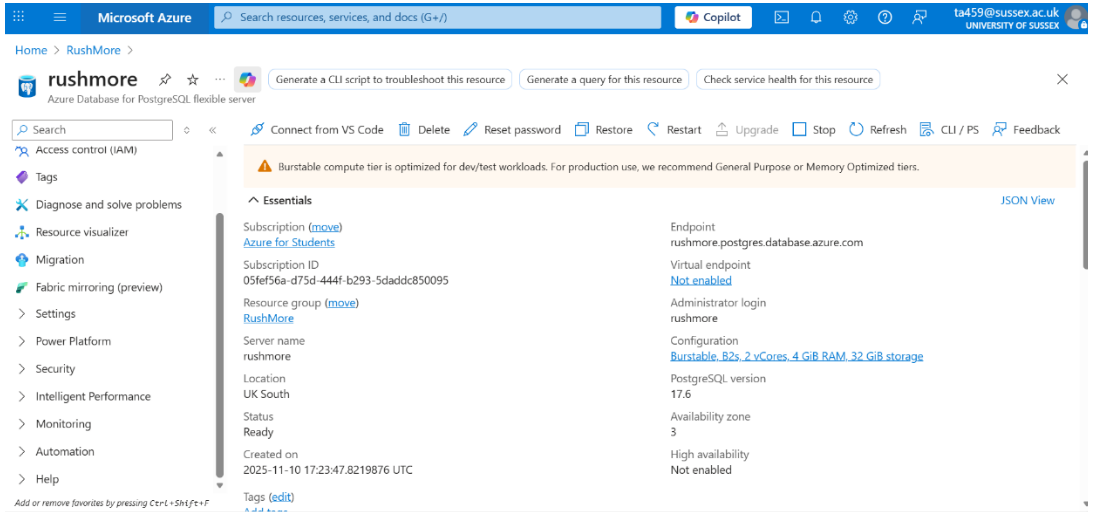
Phase 2: Deploy, Connect Azure Database for PostgreSQL Server to PgAdmin

During this phase I was able to provision PostgreSQL in Azure, which involved creating a resource group, create Azure Database for PostgreSQL and connect it with my PgAdmin on which I already created my **rushmore** database. One thing I observed during this provisioning and connecting is the fact that Azure PostgreSQL give you the option to able to connect to your visual studio code.

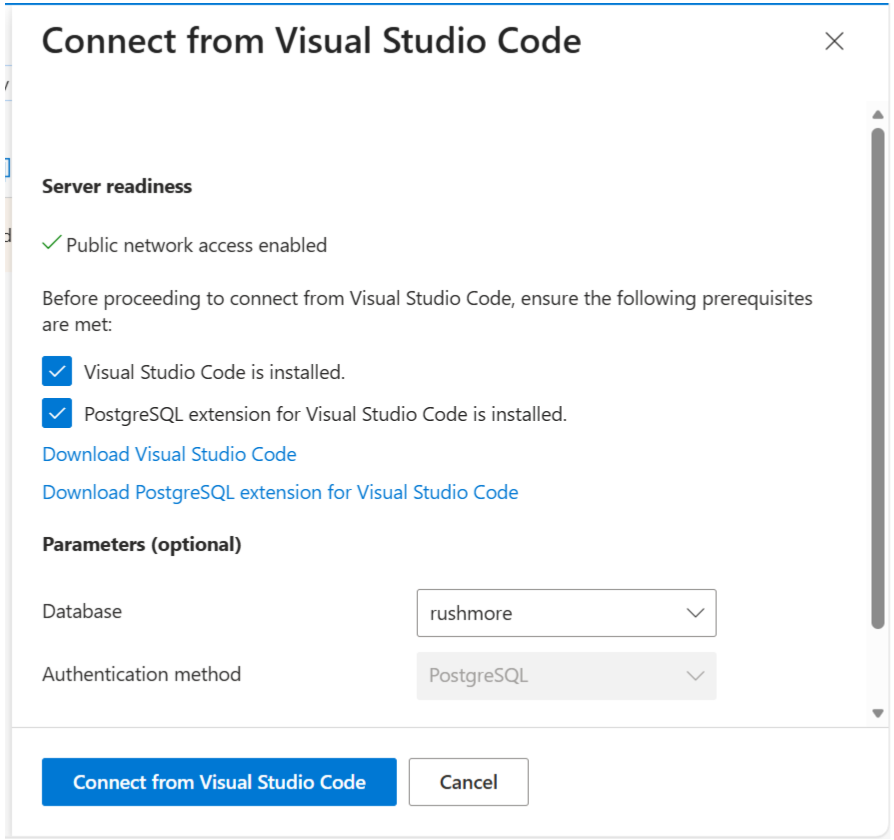


Azure Database for PostgreSQL flexible Server

Azure PostgreSQL under RushMore Resource Group



Connection made to rushmore database on PgAdmin and Visual Studio Code



Design: Writing Schema to .sql

Phase 3: Rushmore.sql

Proceeded to Creating my 7 tables: Stores, Customer, Ingredients, Menu_Items, Item_Ingredients, Orders, and Order_Items.

Defined primary keys, foreign keys, Uniqueness, defaults, and delete behaviors

Key design choices:

1. **Junction tables**

-Item_ingredients links recipes(Menu Item – Ingredient).

-Order-Items links transactions(Order-Menu Item).

2. **Delete rules**

-Orders.customer_id ON DELETE SET NULL: Keep historical orders even if a customer is removed.

Building the database

-Order_Items,order_id ON DELETE CASCADE: delete line items when an order is deleted(no orphans)

-Item_Ingredient.items_id ON DELETE CASCADE: delete recipe rows when a menu item is removed.

-ON DELETE RESTRICT: to protect historical facts(e.g cant delete a store that has Orders).

3. **Data Types & defaults**

-Money as NUMERIC(10, 2)

-Timestamps default to CURRENT_TIMESTAMP

-Natural keys avoided; we use surrogate SERIAL PKs for simplicity and performance.

4. **Normalization**

-No duplicated customer/store data in orders; just FKs.

-Menu catalog and ingredient catalog separated from transactions.

Indexes.sql

What it does

1. Adds secondary indexes to speed up the most common joins and filters used

-Orders (store_id, order_timestamp) –revenue by store over time, busiest hours.

-Order_Items (order_id) & (item_id) – fast join from orders to lines to catalop.

-Item_Ingredients (ingredient_id) – reverse lookup of which items use an ingredient.

-Menu_Items (category, size) – quick slicers on catalog

2. Fk columns are often required, these indexes make those joins efficient.

Our indexes speed reads(queries, dashboards), joins and time filters become index-friendly, so visuals render fast.

indexes.sql > ...

PGSQL Disconnected

```sql
-- indexes.sql
-- Secondary indexes for FK lookups and common analytics filters

BEGIN;

-- ITEM_INGREDIENTS lookups by ingredient
CREATE INDEX IF NOT EXISTS idx_item_ingredients_ingredient_id
  ON Item_Ingredients (ingredient_id);

-- ORDER_ITEMS lookups by order and by item
CREATE INDEX IF NOT EXISTS idx_order_items_order_id
  ON Order_Items (order_id);
CREATE INDEX IF NOT EXISTS idx_order_items_item_id
  ON Order_Items (item_id);

-- ORDERS filtering by store + time (useful for revenue by store, busy hours)
CREATE INDEX IF NOT EXISTS idx_orders_store_timestamp
  ON Orders (store_id, order_timestamp);

-- MENU_ITEMS filtering/grouping by category and size
CREATE INDEX IF NOT EXISTS idx_menu_items_category_size
  ON Menu_Items (category, size);

COMMIT;
```

Constraints.sql – “Keep bad data out”

What it does

1. Adds CHECK constraints to enforce business-valid values:

- Prices and totals ≥ **0**.
- Quatities > **0**.
- Order **status** limited to a known set (Pending, In progress, Delivered, Cancelled).

2. Complements schema NOT NULL/ UNIQUE rules so invalid data cannot be inserted even by mistake or buggy code.

Why it matters

Constraints are guardrails at the database layer, they protect data quality regardless of the client app or script. This makes analytics trustworthy.

Note: Our constraints.sql hardens the model in the sense that numbers must be sensible, statuses valid, so we trust every chart.

constraints.sql > ...

PGSQL Disconnected

```sql
BEGIN;

-- Non-negative money values
ALTER TABLE Menu_Items
  ADD CONSTRAINT menu_items_price_nonneg CHECK (price >= 0);

ALTER TABLE Orders
  ADD CONSTRAINT orders_total_nonneg CHECK (total_amount >= 0);

ALTER TABLE Order_Items
  ADD CONSTRAINT order_items_price_nonneg CHECK (price_at_time_of_order >= 0);

-- Positive quantities
ALTER TABLE Order_Items
  ADD CONSTRAINT order_items_qty_pos CHECK (quantity > 0);

-- Reasonable recipe quantities
ALTER TABLE Item_Ingredients
  ADD CONSTRAINT item_ing_qty_pos CHECK (quantity_required > 0);

-- Status whitelist (optional; keep only the statuses you use)
ALTER TABLE Orders
  ADD CONSTRAINT orders_status_valid CHECK (status IN ('Pending','In Progress','Delivered',
```

Access_role_based.sql

Role based access control**(RBAC)** script was created which includes an admin role, data engineer, data analyst, data scientist, customer service and self service with clear privilege boundaries between them. All user have login + password. My script is safe for production, works in PostgreSQL and follows least-privilege design.

Admin: Controls the full schema, they can create tables, alter structures, add constraints, and manage privilege. It is the highest non super user role.

Data Engineer: maintains pipelines and ETL processes, they have full read/write access to all production tables but cannot change the schema.

Data Analyst: Analyst are read only. They can query all tables and views but cannot change any data.

Data Scientist: Scientist can read production data and have a dedicated sandbox schema where they can build models, run experiments, and create tables safely.

Customer Service Processor: CS staff can update customer profiles and manage orders, but they cannot modify catalog or delete history.

Self Service Role: This role supports a customer-facing application. It can create customers and place orders but cannot modify existing records.

Note: I followed security best practices by keeping real credentials out of source control. The repository includes a **role_template.sql** file with placeholder passwords, an the real **acess_role_based.sql** file is excluded using **.gitignore**, ensuring no secrets are exposed on **Github**.

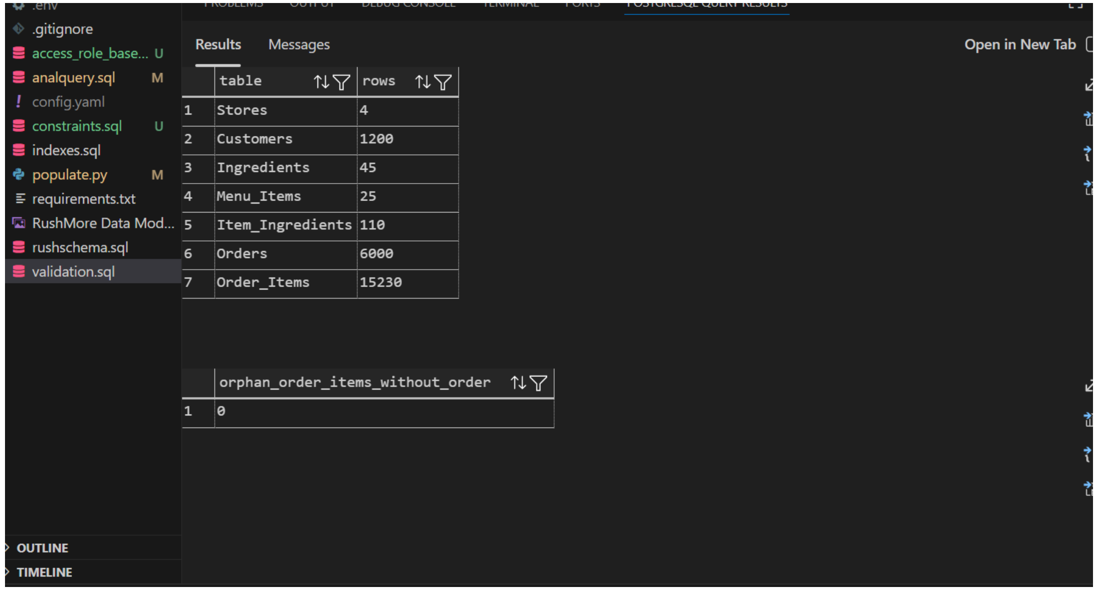
Validation.sql – "Prove it worked" – Run after populate.py

What it does

1. Row-count dashboard: quick volume sanity checks after Faker runs.
2. Orphan checks: LEFT JOIN tests that should return **0** (e.g., Order_Items must always match an Order and a Menu_Item; Orders must match a Store; etc.).
3. Totals reconciliation: verifies Orders.total_amount == SUM(quantity * price_at_time_of_order) – our critical accounting check.
4. Uniqueness scans: confirms there aren't duplicate emails/phones/ingredient names beyong what the schema allows.

Results

1. All orphan checks returned **0.**
2. Totals reconciliation returned no rows(if it did, those are the orders to fix).
3. Row count meet the target volumes.



.sql continued

Cascading In Our rushmore.sql file

You might want to ask why I don't have a cascading.sql file:

My Rushmore.sql already includes cascading where appropriate. Looking at my rushmore.sql where I defined relationship kike this:

order_id INTEGER REFERENCES Orders(order_id) ON DELETE CASCADE

item_id INTEGER REFERENCES Menu_Items(item_id) ON DELETE CASCADE

customer_id INTEGER REFERENCES Customers(customer_id) ON DELETE SET NULL

.

store_id INTEGER REFERENCES Stores(store_id) ON DELETE RESTRICT

So:

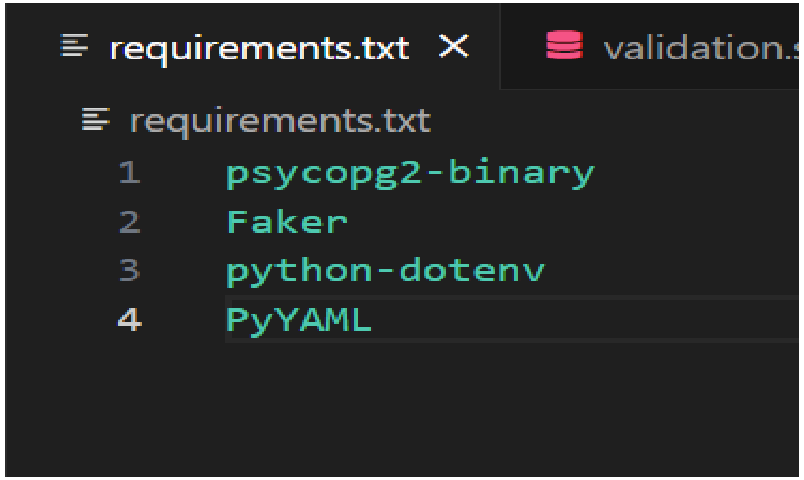
- Some FKs cascade deletes(e.g. if an order is deleted, its order_items delete automatically).
- Some FKs keep data but unlink it(set NULL if a customer is deleted).
- Some FKs restrict deletes(you cant delete a store if it has orders)

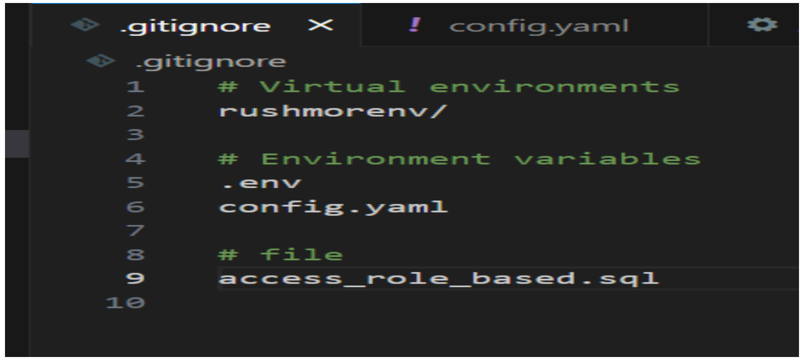
So yes my Rushschema.sql handles cascading automatically, since I used ON DELETE CASCADE on some tables, I don't really need an extra cascading script.

Phase 4: Synthetic data generation

At this point, we write our populate.py that connects to the cloud DB, generates realistic data with Faker, and inserts in dependency-safe order to hit the target volumes. From our Capstone brief which mandates Faker + psycopg2, secrets via env/config, and specific record counts.

Config & Secrets: Here we did not hardcode credentials as I read from .env or config.yaml (host, port, user, password, dbname). Also requirements.txt file was created having my environment dependencies to be installed having psycopg2-binary, Faker, Python-dotenv, MyYaml and I was able to run on my terminal(pip install –r requirements.txt). I created a gitignore file to ignore or not to track my virtual environments with environment variables and file.





Synthetic data generation continued

Target volumes (minimum)

- Stores: 3-5
- Menu_items: 20-30
- Ingredients: 40-50
- Customers: 1000+
- Orders: 5000+
- Order_items: 15000+ (3 items/order)

These volumes are required for stress testing.

Insertion order (honors FK constraints)

1. Stores
2. Customers
3. Ingredients
4. Menu_Items
5. Item_Ingredients (recipes)
6. Orders
7. Order_items

Data realism rules

- Use Faker: fake.name(), fake.phone_number(), fake.email(), fake.address(), fake.date_time_this_year() for order timestamps.

- Order_items.price_at_time_of_order must capture the item price at order time(not the current catalog price).

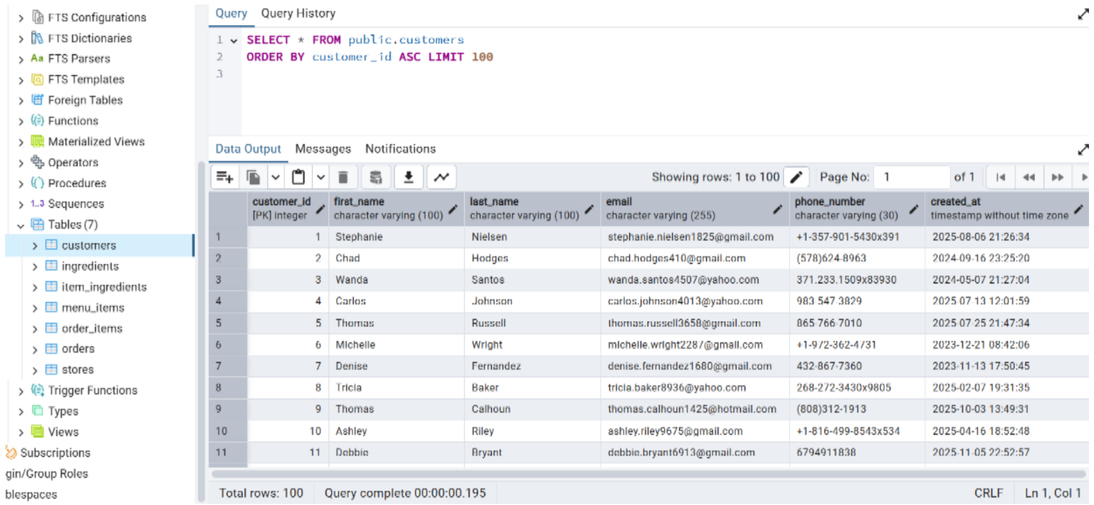
- Orders.total_amount = sum of line totals for that order.

Synthetic data generation continued

Script structure

```
# rushmore/populate.py
# 1) load env/yaml
# 2) connect via psycopg2
# 3) helper: executemany batched inserts, commit per batch
# 4) seed STORES (3-5 cities), INGREDIENTS (40-50), MENU_ITEMS (20-30)
#    - For each menu item, assign 2-6 ingredients & quantities into ITEM_INGREDIENTS
# 5) seed CUSTOMERS (>= 1,000) with unique email/phone
# 6) seed ORDERS (>= 5,000) with timestamps this year, random store & customer
# 7) for each order, create ~3 ORDER_ITEMS:
#      - choose item_id at random
#      - quantity 1-4
#      - price_at_time_of_order = current Menu_Items.price (copied at insert)
# 8) compute & update ORDERS.total_amount
# 9) sanity checks (counts, null scans, FK violations, price sums)
# 10) print summary row counts
```

Proof of Population - Customers



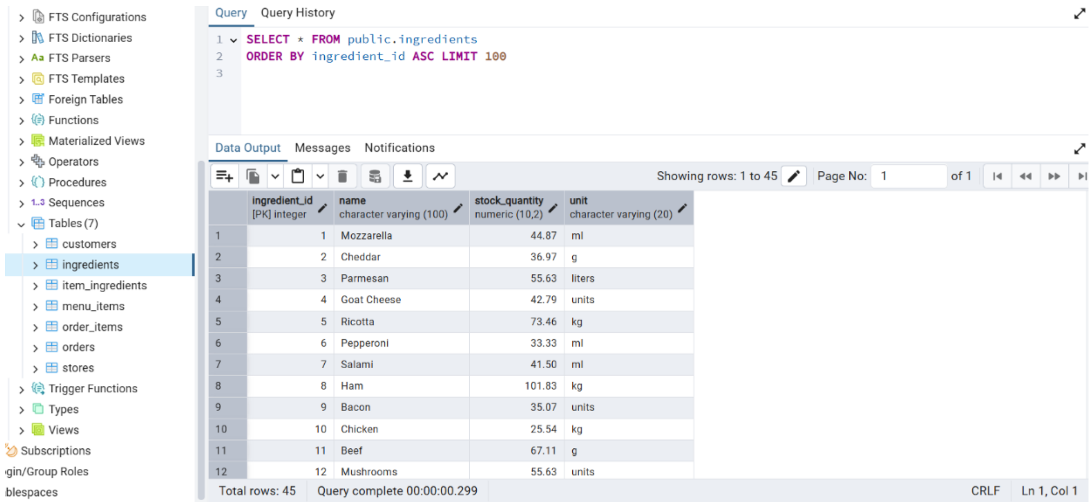

```sql
SELECT * FROM public.customers
ORDER BY customer_id ASC LIMIT 100
```

	customer_id [PK] integer	first_name character varying (100)	last_name character varying (100)	email character varying (255)	phone_number character varying (30)	created_at timestamp without time zone
1	1	Stephanie	Nielsen	stephanie.nielsen1825@gmail.com	+1-357-901-5430x391	2025-08-06 21:26:34
2	2	Chad	Hodges	chad.hodges410@gmail.com	(578)624-8963	2024-09-16 23:25:20
3	3	Wanda	Santos	wanda.santos4507@yahoo.com	371.233.1509x83930	2024-05-07 21:27:04
4	4	Carlos	Johnson	carlos.johnson4013@yahoo.com	983 547 3829	2025 07 13 12:01:59
5	5	Thomas	Russell	thomas.russell3658@gmail.com	865 766 7010	2025 07 25 21:47:34
6	6	Michelle	Wright	michelle.wright2287@gmail.com	+1-972-362-4731	2023-12-21 08:42:06
7	7	Denise	Fernandez	denise.fernandez1680@gmail.com	432-867-7360	2023-11-13 17:50:45
8	8	Tricia	Baker	tricia.baker8936@yahoo.com	268-272-3430x9805	2025-02-07 19:31:35
9	9	Thomas	Calhoun	thomas.calhoun1425@hotmail.com	(808)312-1913	2025-10-03 13:49:31
10	10	Ashley	Riley	ashley.riley9675@gmail.com	+1-816-499-8543x534	2025-04-16 18:52:48
11	11	Debbie	Bryant	debbie.bryant6913@gmail.com	6794911838	2025-11-05 22:52:57

Total rows: 100 Query complete 00:00:00.195 CRLF Ln 1, Col 1

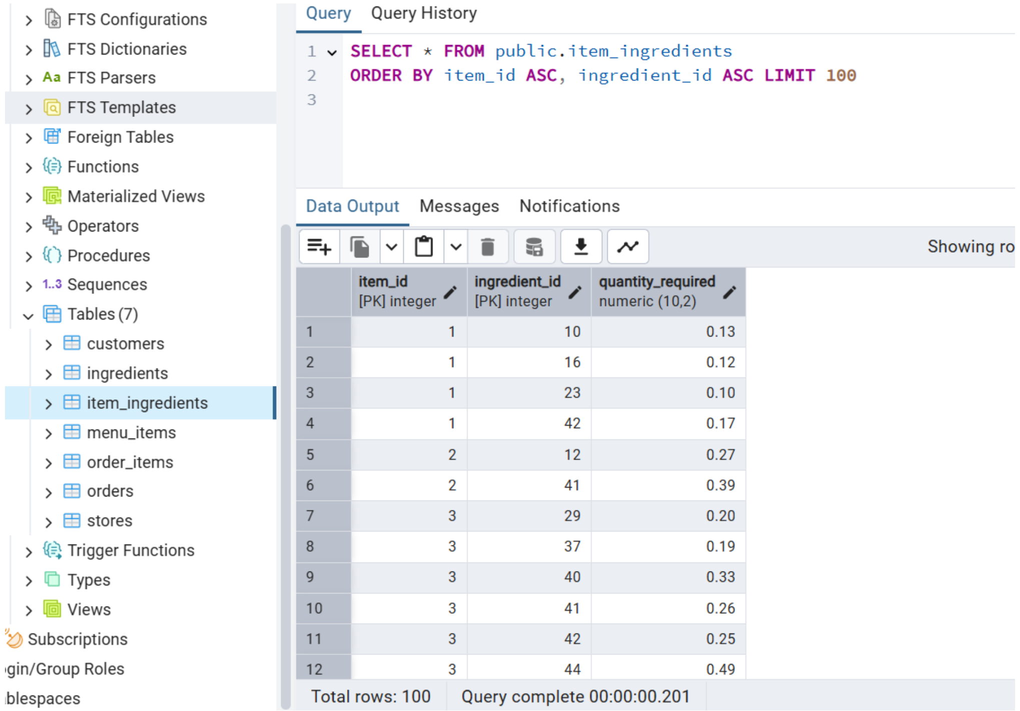
Synthetic data generation continued

Proof of population- Ingredients



	ingredient_id [PK] integer	name character varying (100)	stock_quantity numeric (10,2)	unit character varying (20)
1	1	Mozzarella	44.87	ml
2	2	Cheddar	36.97	g
3	3	Parmesan	55.63	liters
4	4	Goat Cheese	42.79	units
5	5	Ricotta	73.46	kg
6	6	Pepperoni	33.33	ml
7	7	Salami	41.50	ml
8	8	Ham	101.83	kg
9	9	Bacon	35.07	units
10	10	Chicken	25.54	kg
11	11	Beef	67.11	g
12	12	Mushrooms	55.63	units

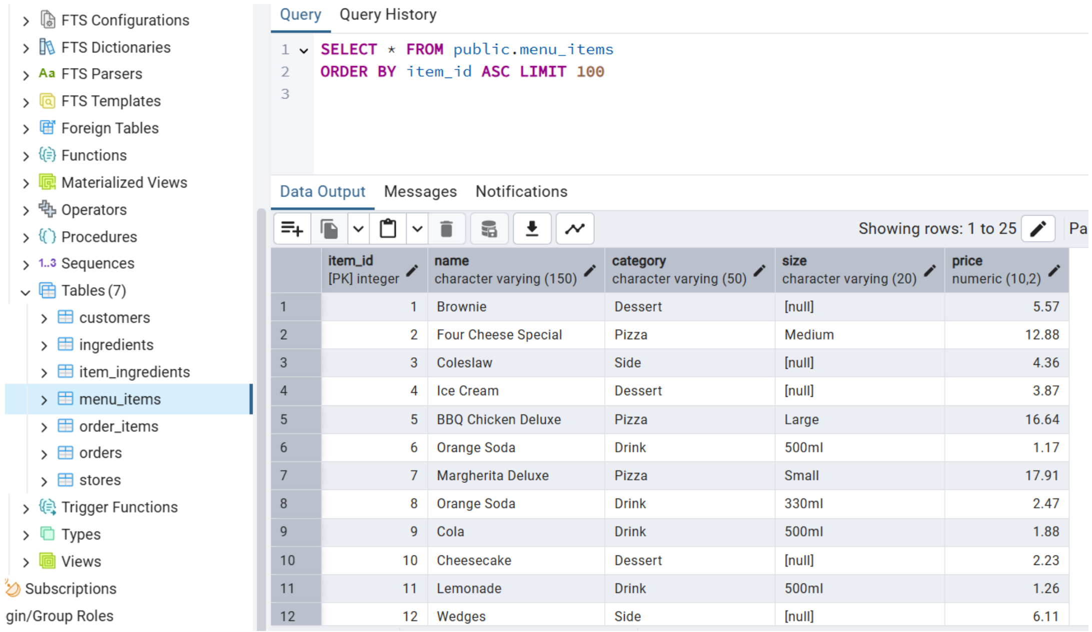
Proof of population- Items_ingredient



	item_id [PK] integer	ingredient_id [PK] integer	quantity_required numeric (10,2)
1	1	10	0.13
2	1	16	0.12
3	1	23	0.10
4	1	42	0.17
5	2	12	0.27
6	2	41	0.39
7	3	29	0.20
8	3	37	0.19
9	3	40	0.33
10	3	41	0.26
11	3	42	0.25
12	3	44	0.49

Synthetic data generation continued

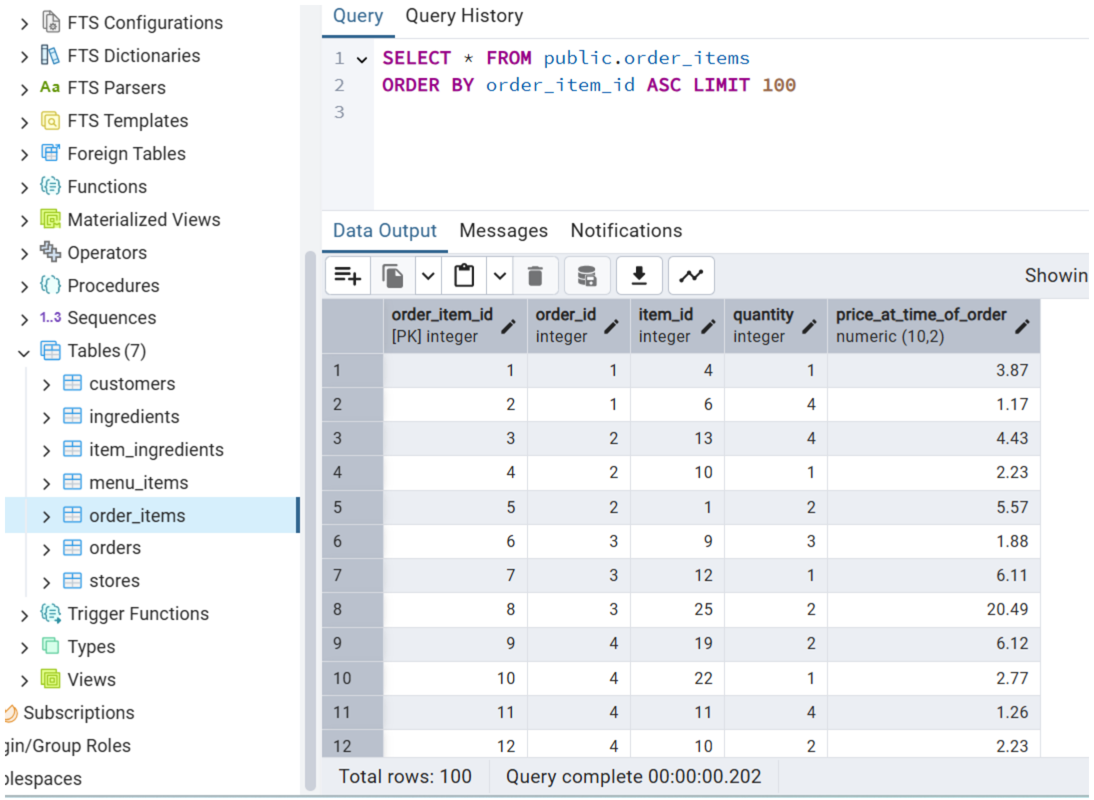
Proof of population- Menu_items




```sql
SELECT * FROM public.menu_items
ORDER BY item_id ASC LIMIT 100
```

	item_id [PK] integer	name character varying (150)	category character varying (50)	size character varying (20)	price numeric (10,2)
1	1	Brownie	Dessert	[null]	5.57
2	2	Four Cheese Special	Pizza	Medium	12.88
3	3	Coleslaw	Side	[null]	4.36
4	4	Ice Cream	Dessert	[null]	3.87
5	5	BBQ Chicken Deluxe	Pizza	Large	16.64
6	6	Orange Soda	Drink	500ml	1.17
7	7	Margherita Deluxe	Pizza	Small	17.91
8	8	Orange Soda	Drink	330ml	2.47
9	9	Cola	Drink	500ml	1.88
10	10	Cheesecake	Dessert	[null]	2.23
11	11	Lemonade	Drink	500ml	1.26
12	12	Wedges	Side	[null]	6.11

Proof of population- Order_items




```sql
SELECT * FROM public.order_items
ORDER BY order_item_id ASC LIMIT 100
```

	order_item_id [PK] integer	order_id integer	item_id integer	quantity integer	price_at_time_of_order numeric (10,2)
1	1	1	4	1	3.87
2	2	1	6	4	1.17
3	3	2	13	4	4.43
4	4	2	10	1	2.23
5	5	2	1	2	5.57
6	6	3	9	3	1.88
7	7	3	12	1	6.11
8	8	3	25	2	20.49
9	9	4	19	2	6.12
10	10	4	22	1	2.77
11	11	4	11	4	1.26
12	12	4	10	2	2.23

Total rows: 100 Query complete 00:00:00.202

Synthetic data generation continued

Proof of population- Orders

- FTS Configurations
- FTS Dictionaries
- FTS Parsers
- FTS Templates
- Foreign Tables
- Functions
- Materialized Views
- Operators
- Procedures
- Sequences
- Tables (7)
  - customers
  - ingredients
  - item_ingredients
  - menu_items
  - order_items
  - orders
  - stores
- Trigger Functions
- Types
- Views
- Subscriptions
- gin/Group Roles
- blespaces

Query | Query History

```sql
SELECT * FROM public.orders
ORDER BY order_id ASC LIMIT 100
```

Data Output | Messages | Notifications

Showing rows: 1 to 100 Page No:

	order_id [PK] integer	customer_id integer	store_id integer	order_timestamp timestamp without time zone	total_amount numeric (10,2)	status character varying (50)
1	1	963	1	2025-06-30 00:15:14	8.55	Cancelled
2	2	765	3	2025-08-24 18:01:40	31.09	Pending
3	3	732	1	2025-06-30 01:54:33	52.73	Delivered
4	4	494	1	2025-09-07 00:02:36	36.11	Delivered
5	5	274	1	2025-04-25 00:28:19	46.39	Delivered
6	6	1119	3	2025-03-12 14:18:02	129.61	In Progress
7	7	952	4	2025-01-15 14:16:48	135.05	In Progress
8	8	277	1	2025-04-14 01:06:12	135.30	Cancelled
9	9	76	3	2024-11-29 13:54:39	84.32	In Progress
10	10	90	2	2025-02-09 05:45:07	98.52	Pending
11	11	647	3	2025-10-05 00:02:51	5.57	Cancelled
12	12	1113	4	2025-02-12 20:39:36	31.87	Delivered

Total rows: 100 Query complete 00:00:00.204

Proof of population- Stores

- FTS Configurations
- FTS Dictionaries
- FTS Parsers
- FTS Templates
- Foreign Tables
- Functions
- Materialized Views
- Operators
- Procedures
- Sequences
- Tables (7)
  - customers
  - ingredients
  - item_ingredients
  - menu_items
  - order_items
  - orders
  - stores
- Trigger Functions
- Types
- Views
- Subscriptions
- gin/Group Roles
- blespaces

Query | Query History

```sql
SELECT * FROM public.stores
ORDER BY store_id ASC LIMIT 100
```

Data Output | Messages | Notifications

Showing rows: 1 to 4 Page No: 1

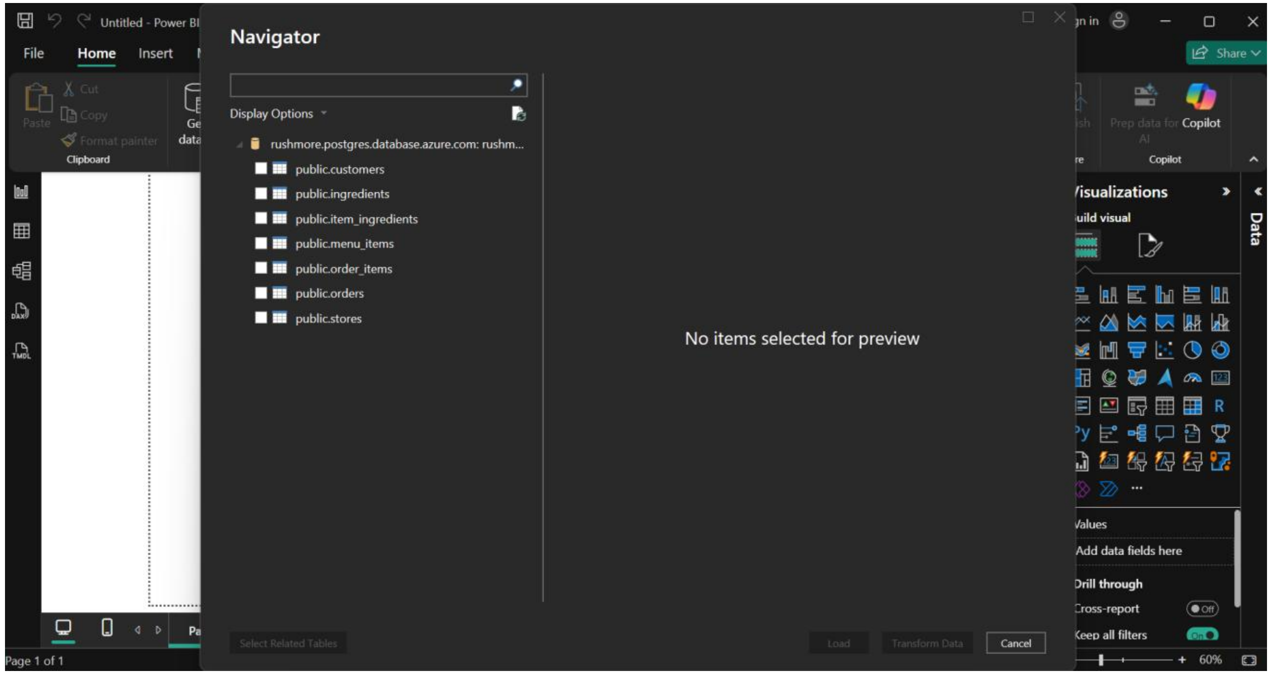
	store_id [PK] integer	address character varying (255)	city character varying (100)	phone_number character varying (30)	opened_at timestamp without time zone
1	1	495 Janet Cape	New Roberttown	+1-634-313-1647x52553	2025-06-15 01:57:24
2	2	327 Nelson Route	North Judithbury	001-783-550-3056x413	2025-08-26 00:25:53
3	3	7242 Julie Plain Suite 969	East Jessetown	(353)828-7101x2269	2024-06-26 15:42:18
4	4	480 Erin Plain Suite 514	Ericmouth	(727)404-8281x48932	2025-02-26 17:24:52

Total rows: 4 Query complete 00:00:00.204

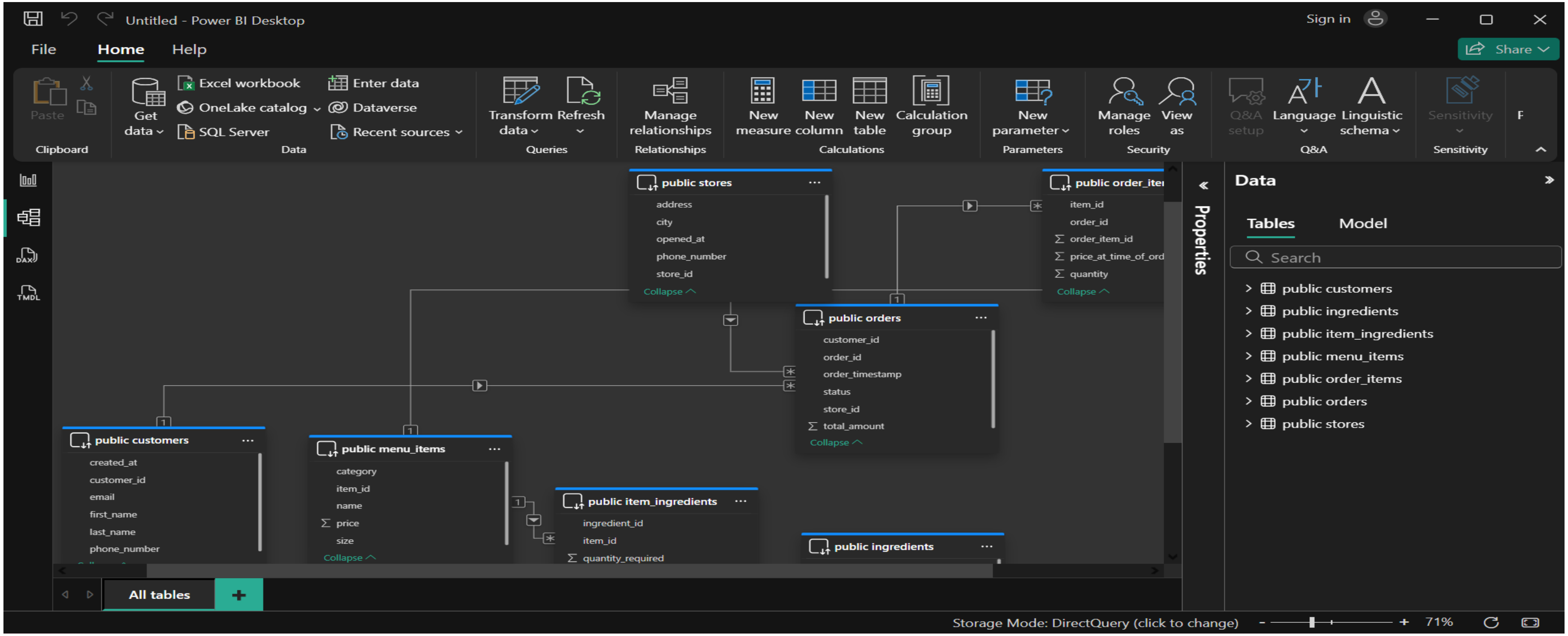
Phase 5: Validation SQL & Analytics(Connect to Power BI & Answer business questions)

After I successfully populate my data generated from Faker, I went ahead to validate my data using the created validation.sql script.

I was able to connect to Power BI as shownb and also created an analquery.sql script which I used to answer the below business questions.

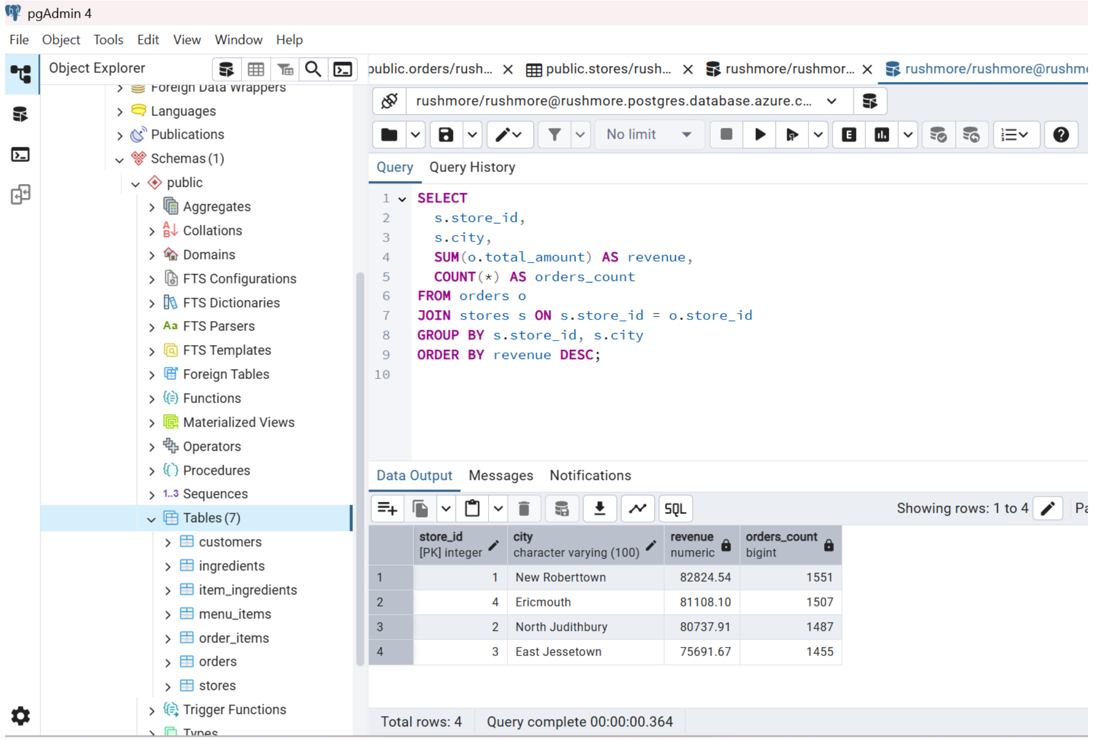


Power BI view of Entity Relationship Diagram

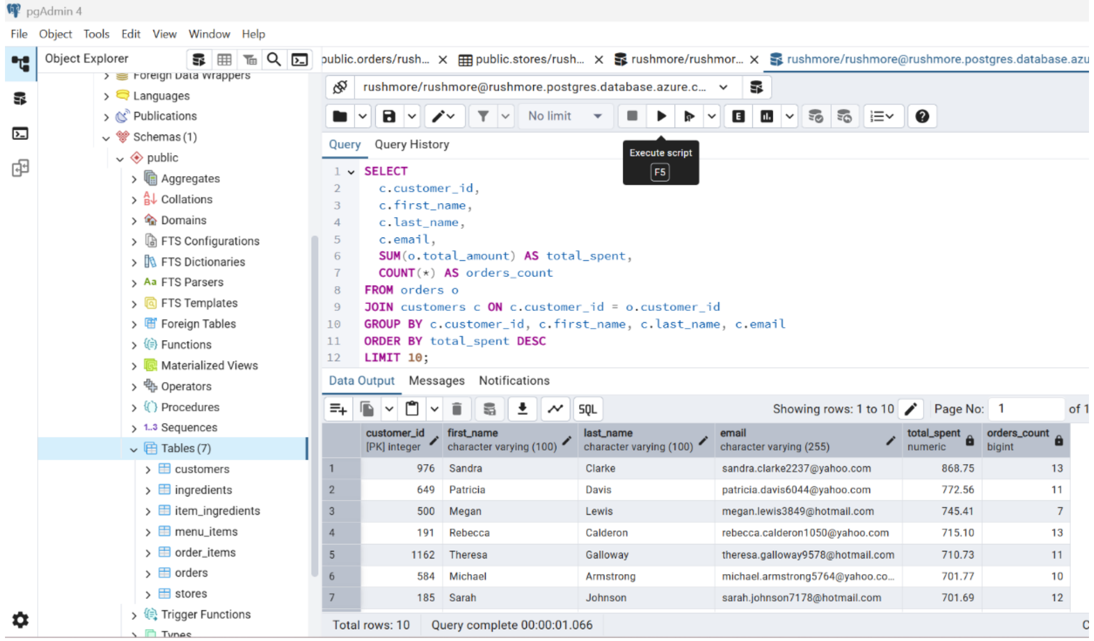


Business Question

Total sales revenue per store

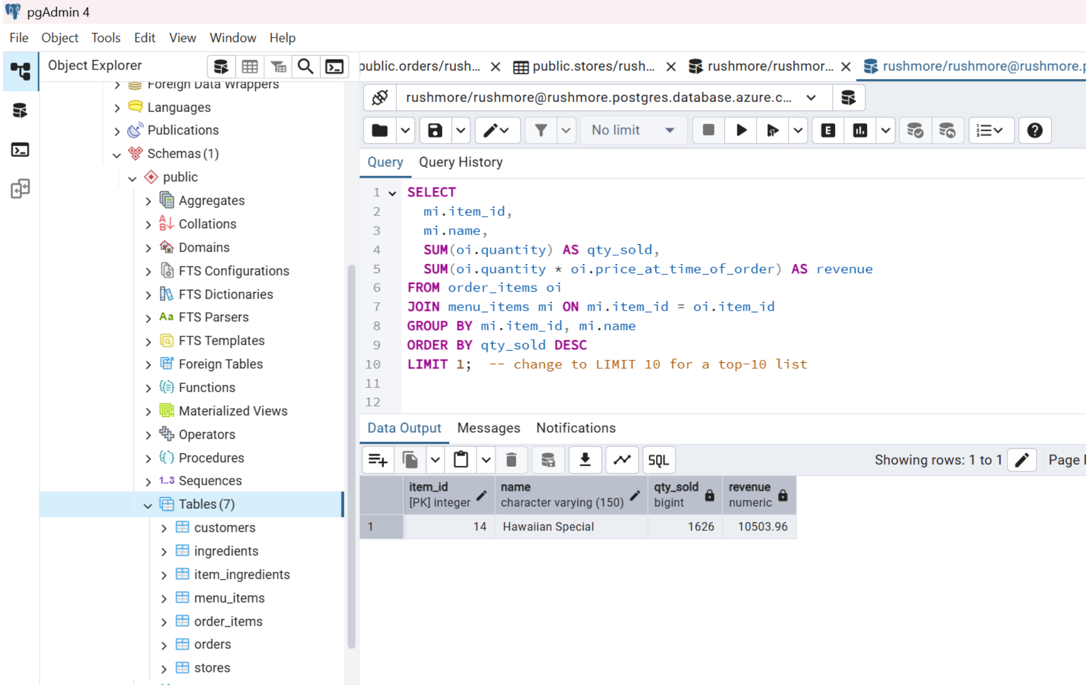


Top 10 customers by spend

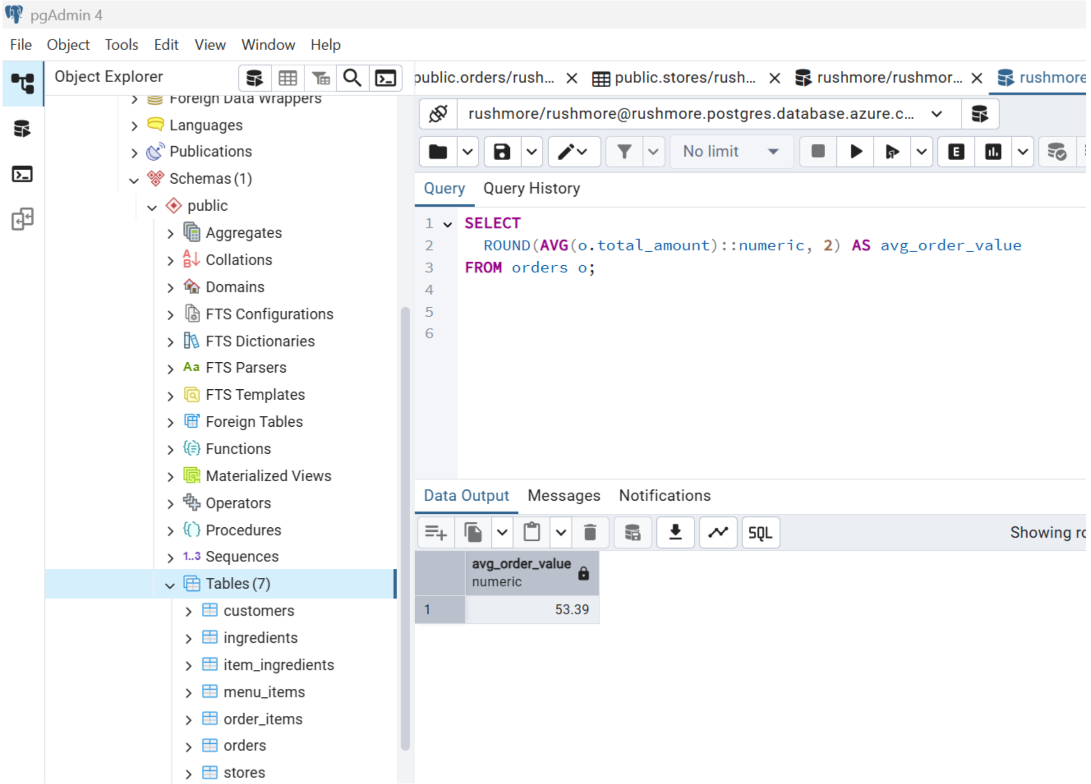


Business Question continued

Most popular menu item(by quantity sold)

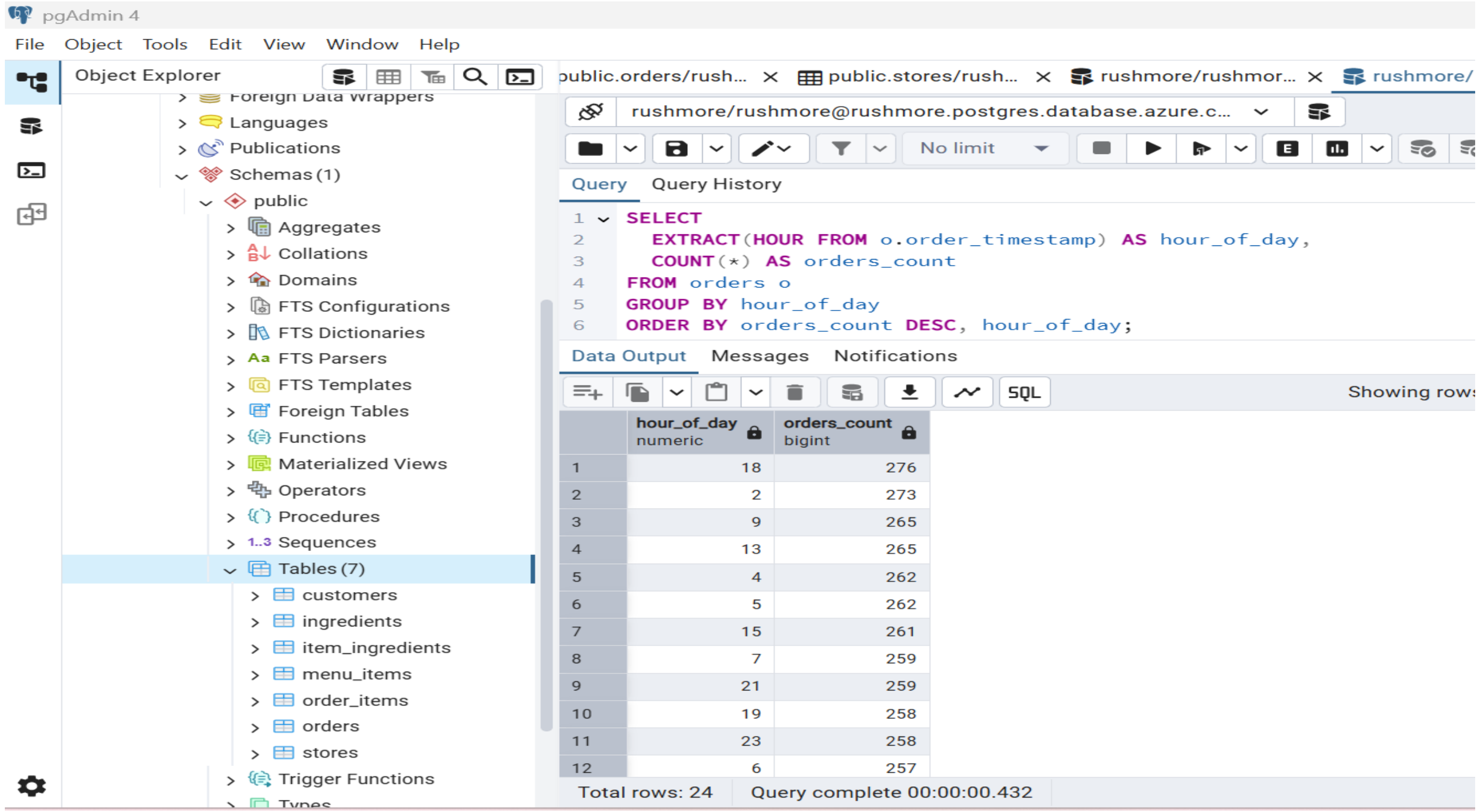


Average order value



Business question continued

Busiest hours of day



Challenges

Challenges

1. The first challenge resolved after watching video on how to connect Azure Database for PostgreSQL server with PgAdmin.
2. During my Population of data using Faker, I got the StringDataRightTruncation error, upon debugging it I noticed faker return phone numbers longer than 20 character(e.g., with spaces, brackets, country codes) but my stores and customers phone number column is VARCHAR(20) and so the insert failed. I went ahead to drop my tables and widen my phone number columns to VARCHAR(30) as I prefer full formatting.
3. I noticed my menu_item size column after data generated has **null** values, I also had to debug where it is coming from as I noticed size was set to N/A(for Side and Desserts) so it becomes **NULL** in postgreSQL. I had to fix that because it is the kind of details that makes projects like this look polished. Since that menu item for side and dessert cannot be either large, medium, small or family as pizza size range, I choose to set it to **Regular**
4. My Power BI connected and I was able to see my table but was unable to fully run my business questions on it as I got error message duplicate values as it is not allowed for columns on the one side of a many to one relationship for columns that are used as the primary key for a table.

Result

- Connected to an Azure PostgreSQL Server using pgAdmin and psql, as I established secure access to my cloud database
- Designed and implemented a fully normalized OLTP schema, my **rushschema.sql** builds a clean, 3rd Normal form(3NF) relational model for a pizza business, drop tables in correct order using **CASCADE** to avoid dependency errors. Optimized performance using **indexes.sql**, protect data quality by enforcing business rules and prevent invalid date from entering the system using **constraints.sql**. I applied role based access so different users have different permissions as seen in my **role_template.sql.**
- Developed python scripts(.py) to generate and load realistic fake data which uses Faker + psycopg2 with thousands of rows(store, customers, menu items, ingredients, recipes, orders and order items).
- Validated all loaded data which confirms no orphaned records, no broken foreign keys, no invalid prices or quantities, order totals match summed line items and Unique constraints are respected.
- Answered key business questions using SQL which I ran analytics queries(revenue by store, top customers, most popular items, busiest hours, etc.).
- Connect Power BI to my Azure PostgreSQL.

This demonstrate a complete modern data engineering workflow:
Design → Build → Populate → Validate → Analyze → Visualize.

Extra – Execution Order

After creating the connection between Azure Database for PostgreSQL server with PgAdmin PostgreSQL and VS Code.

1. Run my schema(**rushschema.sql**)
2. Run **indexes.sql**
3. Run **constraitns.sql**
4. Run RBAC(**access_role_based.sql**), github(**role_template.sql**)
5. Load data with **populate.py**
6. Run **validation.sql** and review outputs.
7. Run **analquery.sql** (see business questions)

PowerPoint 2013

Capstone Project done and presented by

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