

From Text to SQL Agent

Smart Query in Action

Eric Julianto



About Me



[x.com/agonacci](https://www.linkedin.com/in/agonacci)

github.com/agonacci

[linkedin.com/eric-julianto](https://www.linkedin.com/in/eric-julianto)

[instagram.com/eric.julantooo](https://www.instagram.com/eric.julantooo)

Work Experience

- Research Analyst at Braincore
(Dec 21 - Now)
- Machine Learning Mentor at Bangkit Academy
(Feb 23 - Jan 24)
- SEO Intern at Dibilabs by Dibimbing.id
(Mar 23 - Jun 23)
- AI Developer Intern at ZettaByte
(May 22 - Aug 22)

Education

- Hospitality & Tourism at Universitas Bunda Mulia
- Computer Science at Universitas Esa Unggul



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BRAINCORE

Let's talk about SQL Agent



From Text to SQL Agent

Smart Query in Action

Mengubah pertanyaan dalam bahasa natural menjadi SQL query menggunakan LLM

Problem Statement

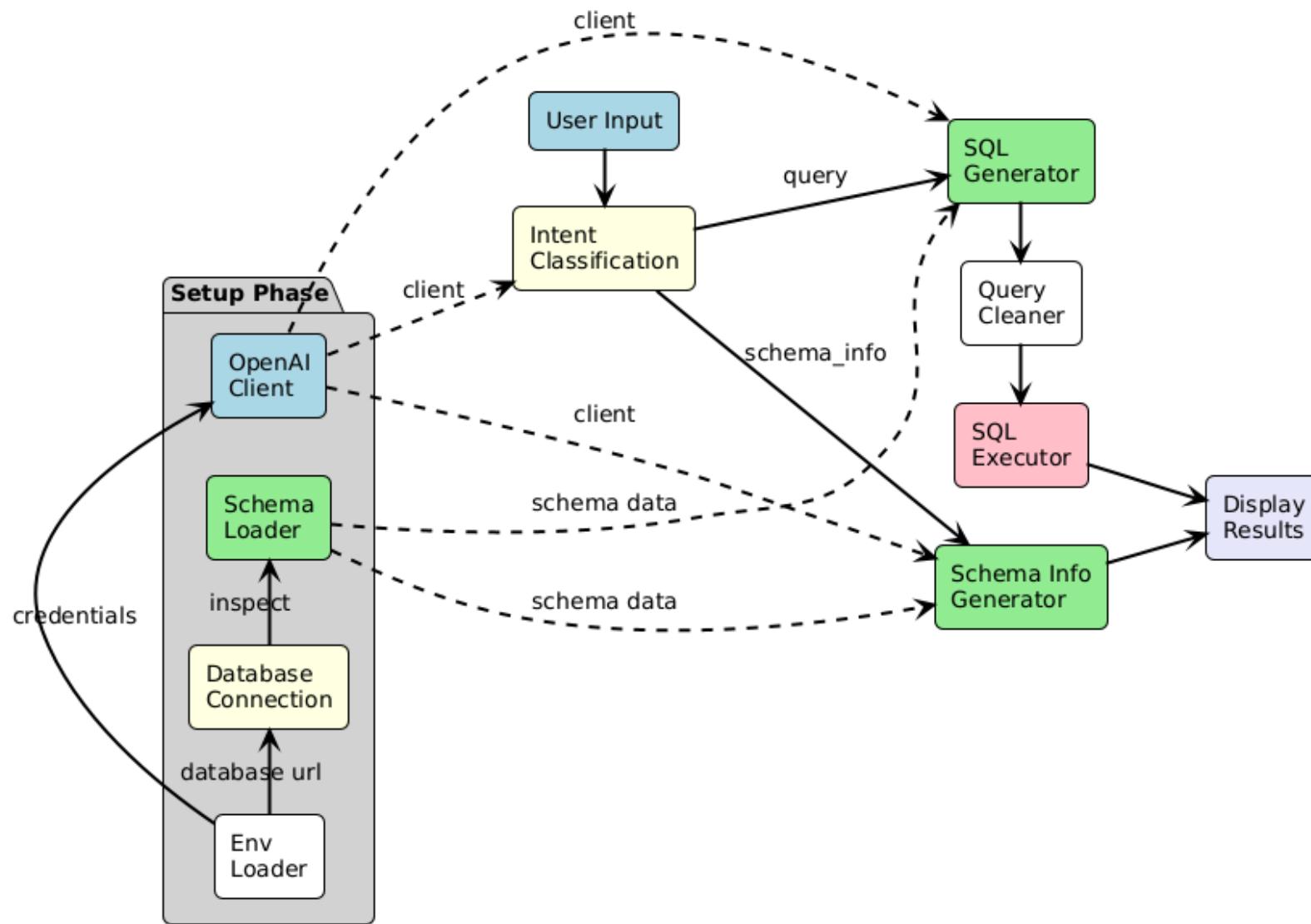
Tantangan:

- SQL syntax sulit dipelajari
- Tidak semua orang familiar dengan database schema
- Query kompleks butuh waktu lama
- Sering typo atau syntax error

Solusi:

- Natural language → SQL
- AI memahami struktur database
- Generate query otomatis
- User-friendly interface

Arsitektur Sistem



How It Works

1. **Input** - User mengetik pertanyaan dalam bahasa natural
2. **Intent Classification** - LLM mengklasifikasi: query atau schema_info
3. **Generation** - LLM membuat SQL query atau info schema
4. **Execution** - Execute query di database (read-only)
5. **Display** - Tampilkan hasil dalam format rapi



Demo Time

Quick Setup Guide

1. Clone Repository

```
1 git clone https://github.com/algonacci/from-text-to-sql-agent  
2 cd from-text-to-sql-agent  
3 cd scripts
```



2. Setup Environment

```
1 cp .env.example .env
```



3. Install Dependencies

```
1 uv sync
```



4. Run the Agent

```
1 uv run simple.py
```



Tips and Tricks

- Prompt engineering
- Context engineering
- Only query `SELECT` statement
- Validate the generated query statement
- Structured prompt
- Role and persona
- Chain-of-Thought (CoT)
- One shot example
- Few shot example
- Explicit instruction
- Output formatting
- Fallback behavior

Challenges and Limitations

1. LLM Accuracy

- Kadang generate query yang tidak optimal
- Butuh prompt engineering yang baik

2. Complex Queries

- JOIN multi-table masih challenging
- Aggregasi kompleks perlu tuning

3. Database Specific

- Dialect SQL berbeda per database
- Perlu testing per platform

Future Improvements

Features:

- Query history & caching
- Query optimization suggestions
- Data visualization
- Export hasil (CSV, Excel)
- Multi-language support

Technical:

- Unit testing
- Query validation
- Web UI (FastAPI + React)
- User authentication
- Mobile app

Use Cases

1. Business Analytics

- Non-technical users query data
- Quick insights tanpa SQL

2. Data Exploration

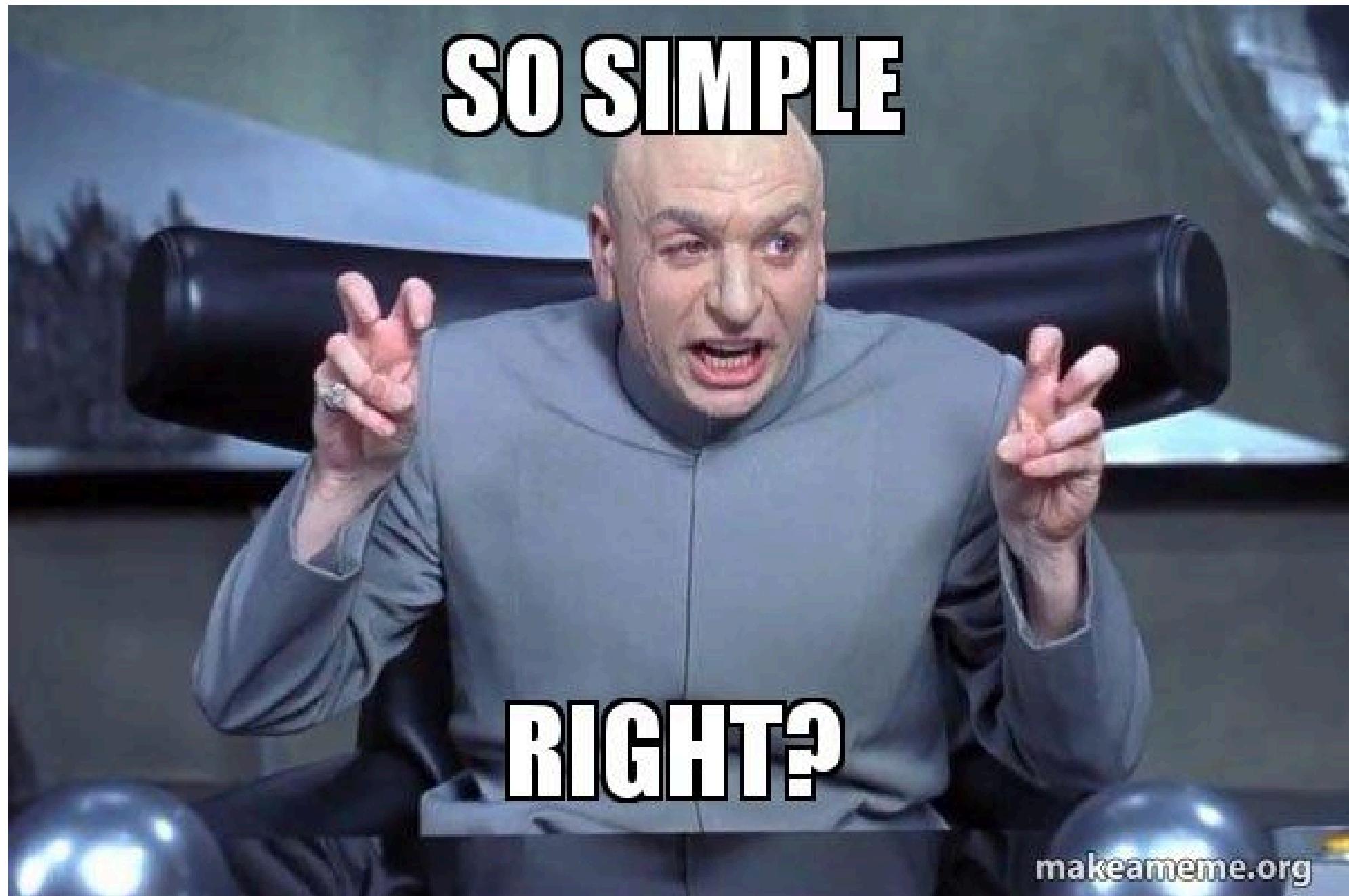
- Explorasi database baru
- Understand schema cepat

3. Prototyping

- Rapid query testing
- Data validation

4. Education

- Belajar SQL dari generated queries
- Understand best practices



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Advanced Case

What if...

What if...

- Multi Database
 - Lebih dari 1 database
 - Cross-database queries
- Dialek Berbeda
 - PostgreSQL, MySQL, SQL Server
 - Syntax compatibility issues
- Scale Challenge
 - Jumlah row sudah jutaan
 - Performance optimization needed
- Complex Schema
 - Jumlah tabel sudah ratusan
 - Dependency mapping
- Security & Privacy
 - Sensitive data handling
 - Row-level security
- Real-time Analytics
 - Streaming data
 - Live dashboard queries

Cara Tackle Advanced Case

Hybrid Approach: Template-based + LLM Fallback

Template Pipeline (~5-10s)

Pattern Matching → SQL Templates → Execute

LLM Pipeline (~30-60s)

Intent → Routing → Schema Filter → SQL Gen → Format

Key Solutions

Multi-DB: Session registry mapping

Scale: 2-stage schema filtering

Security: SQL sanitization guards

Performance: Template caching

Complexity: Foreign key graph

SQL Template Example

Query: “Tampilkan user yang aktif dengan role admin”

Pattern: USER_LIST_FILTER → Variables: {status: "active", role: "admin", limit: 50}

```
1 SELECT
2     u.id, u.name, u.email,
3     u.role, u.status,
4     u.created_at
5 FROM users u
6 WHERE u.status = '{status}'
7     {role_filter}
8     AND u.deleted_at IS NULL
9 ORDER BY u.created_at DESC
10 LIMIT {limit};
```

Filled Template: {role_filter} → AND u.role = 'admin'

Result: Fast, consistent, predictable SQL generation

Deep Dive: Schema Filtering

Problem: Ratusan tabel → LLM hallucination & slow

Solution: 2-Stage Filtering

Stage 1: Graph-based

Required tables + neighbors via FK graph Structured prompt

200 tables → ~30 tables Few-shot examples

Stage 2: LLM Refinement

Chain-of-Thought reasoning + confidence scoring Chain-of-Thought

30 tables → 5-10 tables Role & persona definition

Explicit instructions

Fallback behavior

Security: SQL Sanitization

Guards Module

```
1 def sanitize_sql(sql: str):
2     # Only allow SELECT/WITH
3     if not starts_with_select():
4         raise ValueError()
5
6     # Block dangerous keywords
7     if has_forbidden_tokens():
8         raise ValueError()
9
10    # Prevent SQL injection
11    if has_multiple_statements():
12        raise ValueError()
13
14    # Force LIMIT
15    ensure_limit(default=500)
```

Protection Against

SQL Injection

DROP TABLE attacks

Multi-statement execution

Unbounded queries

Comment-based bypasses

Read-only enforcement pada database level

Multi-Database Handling

Session Registry Pattern

```

1 SESSION_REGISTRY = {
2   "db_1": SessionMySQL,
3   "db_2": SessionMariaDB,
4   "db_3": SessionPSQL,
5   "db_4": SessionMariaDB
6 }
```

Auto-routing based on

Intent classification

Keyword mapping

Table requirements



Dialect-aware SQL Templates

PostgreSQL: DATE_TRUNC

MySQL: YEAR(), DATE_FORMAT

MariaDB: JSON functions

Dynamic template selection

berdasarkan detected database

Performance Optimization

Template-based Pipeline

17 pre-built SQL templates

Pattern matching ~2-3s

Total query time ~5-10s

99%+ consistency

Pattern Definitions

JSON-based pattern library

Variable extraction rules

Default value fallbacks

Optimization Techniques

Forced LIMIT on queries

Schema pre-filtering

Foreign key graph caching

Confidence-based routing

Lazy LLM fallback

Trade-off: Speed vs Flexibility



Demo Time (Part 2)

Key Takeaways

1. LLM + Database = Powerful Combo

- Natural language accessibility
- Reduce learning curve

2. Modular Architecture Matters

- Easy to maintain
- Easy to extend

3. User Experience is Key

- Error handling
- Helpful messages
- Smooth interactions



Resources

Project Repository:

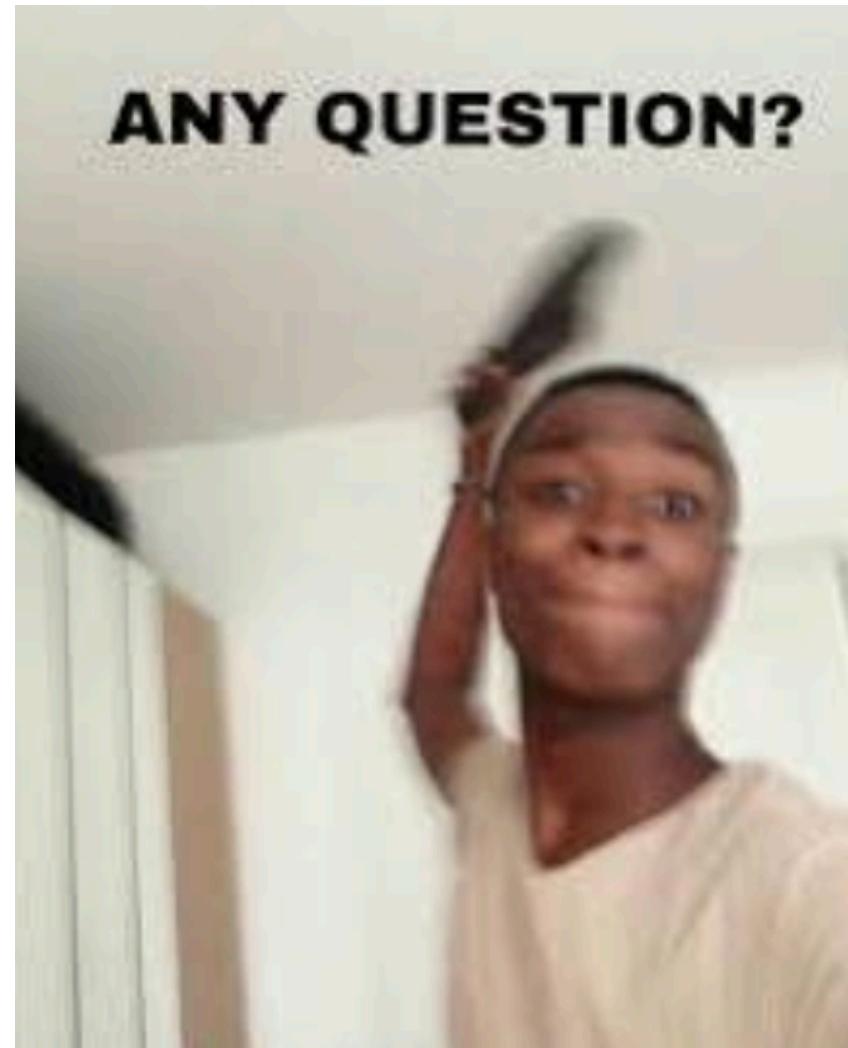
<https://github.com/algonaacci/from-text-to-sql-agent>

Short Link:

<https://s.id/sql-agent-bandungpy>



Q&A



Thank you for listening!