Enabling SQL testing in Airflow workflows using Pydantic types

3.0

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Agenda

1. The Problem
2. SQL Testing Framework
3. Culture Shift
4. Future

The Problem

3.0

The $80 Billion Question

September 2016: Facebook's Admission

Wrong video metrics reported to advertisers for two years!

- Average viewing time overstated by 80%
- Affected billions in advertising decisions
- Discovered after TWO YEARS in production

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Facebook Overestimated Key Video Metric for Two Years

Social network miscalculated the average time users spent watching videos on its platform

Source: WSJ

It's Not Just Facebook

Monday Morning 😰

"Why are yesterday's revenue numbers different today?" *-- Someone's JOIN is -- creating duplicates*

Wednesday Afternoon 🤬

"The exec dashboard is wrong. AGAIN." *-- That 'quick fix' broke -- three downstream queries*

Friday 5 PM 💀

"We just billed customers wrong. All hands on deck." *-- Missing WHERE clause -- in the billing calculation*

The Truth: Every team has their own Facebook moment brewing

The Hidden Complexity of SQL

```sql
WITH fruits AS (
  SELECT 'apple'  AS fruit, 3.55 AS price
  UNION ALL
  SELECT 'banana', 2.10
  UNION ALL
  SELECT 🔥, 4.30
)
SELECT MAX_BY(fruit, price) AS fruit
FROM fruits;
```

What is the output of this SQL Query ?

Depends if 🔥 is null or not null

apple - for clickhouse, duckdb

null - for athena, bigquery and snowflake

* Athena Breaking Changes Across Versions - https://docs.aws.amazon.com/athena/latest/ug/engine-versions-reference-0003.html#engine-versions-reference-0003-breaking-changes

The Uncomfortable Truth

We Don't Have Time

- Testing seen as overhead
- Pressure to ship fast
- Technical debt accumulation

SQL is Simple

- Underestimating complexity
- No testing framework
- Trust without verification

Most semantic SQL changes are manually tested at best, relying on production alerts to catch failures

SQL Testing Framework

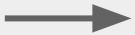
3.0

Design Principles

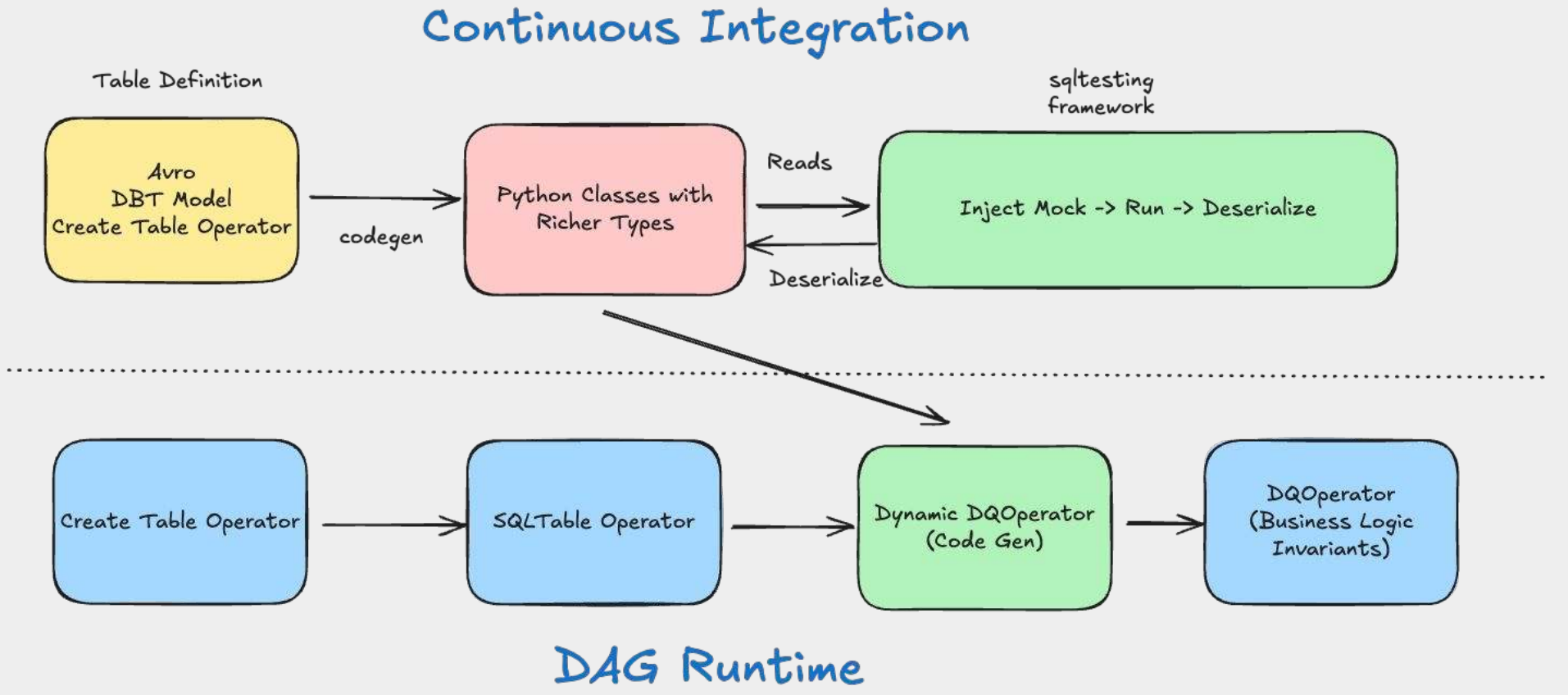
- **Zero or Minimal Footprint:** Tests should avoid creating any artifacts whenever possible.
- **Ease of Use & Extensibility:** Writing and maintaining test cases should be as simple as writing SQL.
- **Dynamic & Adaptive Testing:** Instead of relying solely on predefined test cases, our library should have the ability to automatically surface new issues as data evolves.

The Magic - CTE Injection

```python
def test_simple_user_query():
    @sql_test(
        mock_tables=[
            UsersMockTable([User(1, "Alice",'alice@fb.com')]),
            UsersMockTable([User(2, "Bob",'bob@fb.com')])
        ],
        result_class=User,
    )
    def test_user_query():
        return TestCase(
            query="SELECT * FROM users WHERE user_id = 1"
        )
    results = test_user_query()
    assert len(results) == 1
    assert results[0].name == "Alice"
    assert results[0].user_id == 1
```



```sql
WITH users AS (
    -- Injected mock data
    SELECT * FROM (
        VALUES
        (1, 'Alice', 'alice@fb.com'),
        (2, 'Bob', 'bob@fb.com')
    ) AS t(user_id, name, email)
)
-- Your original query
SELECT * FROM users WHERE user_id = 1
```


Continuous Integration
Table Definition
Avro
DBT Model
Create Table Operator
codegen
Python Classes with
Richer Types
Reads
Deserialize
sqltesting
framework
Inject Mock -> Run -> Deserialize
Create Table Operator
SQLTable Operator
Dynamic DQOperator
(Code Gen)
DQOperator
(Business Logic
Invariants)
DAG Runtime

Where does it fit?

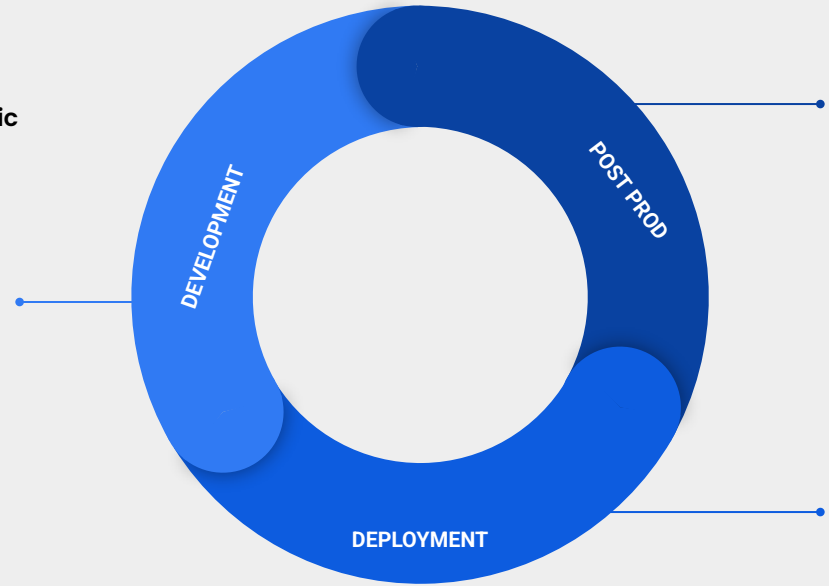
🧪 SQL Testing - Will my logic work?

✅ Test business logic

✅ Validate calculations

✅ Catch bugs early

BEFORE you deploy



📊 DQ Monitors - Is my data healthy?

✅ Monitor anomalies

✅ Track freshness

✅ Alert on issues

AFTER it's running

🔧 DQ Operator/DBT Tests - Is my model sound?

✅ Test structure

✅ Check constraints

✅ Verify relationships

AS you transform

Culture Shift 3.0

The Elephant in the Room

But Writing Tests Takes Too Much Time!

The Perceived Cost 😰

- Writing test: 30 minutes
- Maintaining test: 10 minutes/month
- Running tests: 5 minutes

“We don't have time for this!"

The Hidden Cost of NOT Testing 💸

One production bug can take **up to 120 engineer hours per incident**. Plus, **lost revenue**, **customer trust**, **team burnouts**.

Math below:

- Detection: 2-48 hours (it's Friday night)
- War room: 8 engineers × 6 hours = 48 hours
- Fix & deploy: 4 hours
- Data cleanup: 16 hours
- Post-mortem: 8 hours

But How Do We Actually Get There?

Month 1

Phase 1

Start Where It Hurts

Test only the broken queries

```
if query in ["revenue_calc", "user_metrics", "that_evil_join"]:

    write_test()  # Just these 3 queries
```

- Immediate value
- Team sees immediate benefits
- No overwhelming commitment

But How Do We Actually Get There?

Month 2

Phase 2

New Code Rule

All new queries must have test

```
if query.is_new():

    require_test()  # Going forward, not backward
```

- No technical debt increase
- Gradual coverage growth
- Developers learn by doing

But How Do We Actually Get There?

Month 3 - 6

Phase 3

The Boy Scout Rule

when you touch it, test it

```
if query.is_modified():

    add_or_update_test()  # Leave it better
```

- Organic coverage increase
- Tests stay relevant
- Knowledge spreads naturally

But How Do We Actually Get There?

Month 6 - 12

Phase 4

Full Coverage Sprint

Dedicated Effort for critical path

```
for query in critical_business_queries:

    backfill_test()  # Systematic coverage
```

- Risk-based prioritization
- Measurable progress
- Celebrate milestones

Making It Stick

The Transformation Journey

- **Skepticism** 😒 "This is just more process"
  - Action: Show, don't tell. Live demo of catching a real bug.
- **Curiosity** 🤔 "Okay, that actually would have saved us last month"
  - Action: Pair with skeptics on their first test.
- **Early Adoption** 😊 "I wrote a test and it caught something!"
  - Action: Celebrate publicly. Share success in stand-up.
- **Momentum** 🚀 "Can we test our ETL pipeline too?"
  - Action: Expand scope. Provide advanced training.
- **New Normal** 💪 "PR without tests? That's weird."
  - Action: It's now just how we work.

Future

Vision

- AI-powered test generation
    - Claude is really good at test case generation!
- Multi-cloud testing
- Auto generate DQ checks based on richer data types
- Query engine migration testing
- Perf evaluations - not just correctness

Open Source

Project: **sqltesting**

A powerful Python framework for unit testing SQL queries with mock data injection across BigQuery, Snowflake, Athena, Trino, Redshift, and DuckDB.

Project: **mocksmith**

Type-safe data validation with automatic mock generation for Python dataclasses and Pydantic models. Build robust data models with database-aware validation and generate realistic test data with a single decorator.

Questions?