Using DuckDB as an Intelligent ETL tool for PostgreSQL

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There is a lot of hype around DuckDB these days. At one PostgreSQL conference, I even saw a large poster comparing DuckDB with PostgreSQL, presenting DuckDB as a superior tool. Having worked with various databases over many years, I was really curious about this new tool and decided to test it deeper. My experiments confirmed that DuckDB is indeed a valuable tool, filling gaps in areas where other databases fall short or show limited focus.

I love DuckDB. It is already a powerful tool and has the potential to be a game-changer for specific use cases within the next year. However, by my opinion some articles rather exaggerate its current capabilities. It only reached production maturity in June of this year and is currently at version 1.1.2, which has addressed many bugs. Some compelling extensions, which I would love to use and recommend to clients, remain marked as "experimental." But hopefully in the next six to twelve months, DuckDB will truly shine. That said, it already supports significant use cases today. So let us dive into one.

I have always worked with big data, including importing large external data files into PostgreSQL and MySQL. A few years ago, ad-hoc import of a CSV file several gigabytes in size into these databases was almost a celebrated achievement. Even now, it requires manual checks and preparations, especially in PostgreSQL. Existing external tools are not always user friendly and most of them are really slow. This is why I am thrilled that DuckDB can greatly streamline this process..

What sets DuckDB apart when working with external data files is its simplicity. There is no need to create database objects manually or even check the file's structure beforehand. DuckDB implements external data sources via table functions API, enabling us to select data from external files directly within the `FROM` clause of a query.

But what is the most amazing part about DuckDB when it comes to external data files, is the absolute simplicity of usage. No need to create any object manually, no need to even check structure of the file. DuckDB implements all external data sources through table functions API. Which means we can directly select data from the external file in the FROM clause of the query.

For my tests, I used a 100-million-row dataset from Kaggle. This 4.5 GB CSV file contains 113 million rows of Japanese trade statistics dating back to 1988. The structure is loosely described as eight INT columns, and the file lacks a header. In the past, importing this type of data would typically involve several minutes of manual setup and problem-solving.

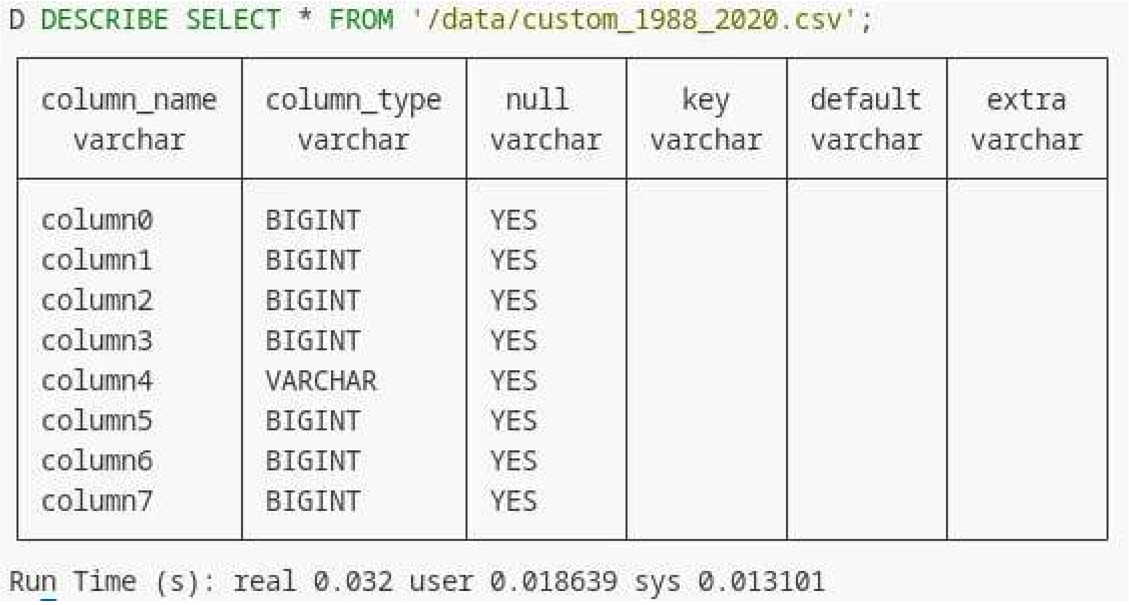
DuckDB, however, handled this file effortlessly. The data selection was as simple as:

```
SELECT * FROM '/data/custom_1988_2020.csv';
```

To inspect the file structure, I used:

```
DESCRIBE SELECT * FROM '/data/custom_1988_2020.csv';
```

To my surprise, DuckDB immediately identified an issue with the dataset: numeric values in column 5 were formatted as strings, causing conversion errors when attempting to import the data as eight INT columns, as described on Kaggle. DuckDB flagged this issue in just 0.03 seconds.

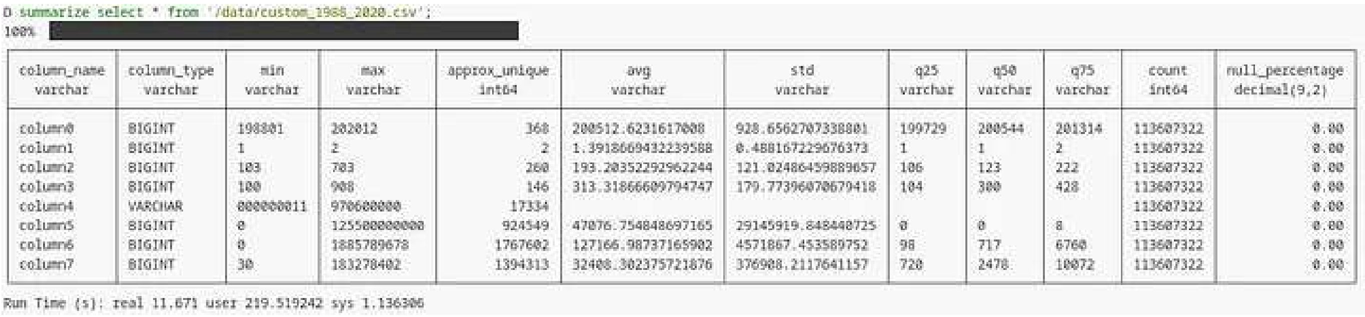


```
D DESCRIBE SELECT * FROM '/data/custom_1988_2020.csv';
┌─────────────┬─────────────┬─────────┬─────────┬─────────┬─────────┐
│ column_name │ column_type │  null   │   key   │ default │  extra  │
│   varchar   │   varchar   │ varchar │ varchar │ varchar │ varchar │
├─────────────┼─────────────┼─────────┼─────────┼─────────┼─────────┤
│ column0     │ BIGINT      │ YES     │         │         │         │
│ column1     │ BIGINT      │ YES     │         │         │         │
│ column2     │ BIGINT      │ YES     │         │         │         │
│ column3     │ BIGINT      │ YES     │         │         │         │
│ column4     │ VARCHAR     │ YES     │         │         │         │
│ column5     │ BIGINT      │ YES     │         │         │         │
│ column6     │ BIGINT      │ YES     │         │         │         │
│ column7     │ BIGINT      │ YES     │         │         │         │
└─────────────┴─────────────┴─────────┴─────────┴─────────┴─────────┘
Run Time (s): real 0.032 user 0.018639 sys 0.013101
```

Another amazing feature is DuckDB's ability to create basic column statistics with minimal effort. Using:

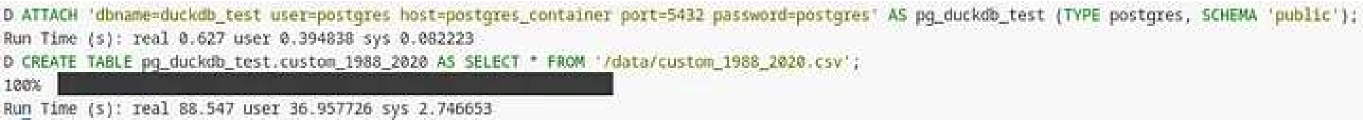
```
SUMMARIZE SELECT * FROM '/data/custom_1988_2020.csv';
```

I received comprehensive statistics within approximately 12 seconds. Doing this in other databases would require writing custom analytical queries first, which makes DuckDB a clear winner for quick data profiling.



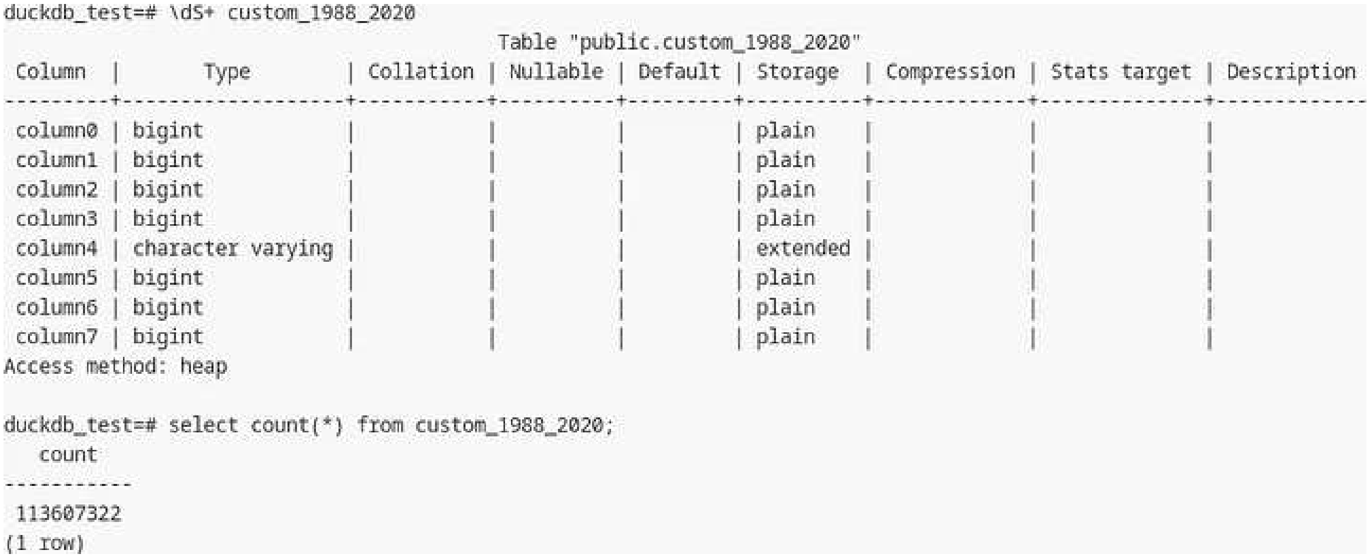
```
D summarize select * from '/data/custom_1988_2020.csv';
100% ▕████████████████████████████████████████████████████████████▏
┌─────────────┬─────────────┬───────────┬──────────────┬───────────────┬────────────────────┬────────────────────┬─────────┬─────────┬─────────┬───────────┬─────────────────┐
│ column_name │ column_type │    min    │     max      │ approx_unique │        avg         │        std         │   q25   │   q50   │   q75   │   count   │ null_percentage │
│   varchar   │   varchar   │  varchar  │   varchar    │     int64     │      varchar       │      varchar       │ varchar │ varchar │ varchar │   int64   │  decimal(9,2)   │
├─────────────┼─────────────┼───────────┼──────────────┼───────────────┼────────────────────┼────────────────────┼─────────┼─────────┼─────────┼───────────┼─────────────────┤
│ column0     │ BIGINT      │ 198801    │ 202012       │           368 │ 200512.6231617008  │ 928.6562707338801  │ 199729  │ 200544  │ 201314  │ 113607322 │            0.00 │
│ column1     │ BIGINT      │ 1         │ 2            │             2 │ 1.3918669432239588 │ 0.488167229676373  │ 1       │ 1       │ 2       │ 113607322 │            0.00 │
│ column2     │ BIGINT      │ 103       │ 703          │           260 │ 193.20352292962244 │ 121.02486459889657 │ 106     │ 123     │ 222     │ 113607322 │            0.00 │
│ column3     │ BIGINT      │ 100       │ 908          │           146 │ 313.31866609794747 │ 179.77396070679418 │ 104     │ 300     │ 428     │ 113607322 │            0.00 │
│ column4     │ VARCHAR     │ 000000011 │ 970600000    │         17334 │                    │                    │         │         │         │ 113607322 │            0.00 │
│ column5     │ BIGINT      │ 0         │ 125500000000 │        924549 │ 47076.754848697165 │ 29145919.848440725 │ 0       │ 0       │ 8       │ 113607322 │            0.00 │
│ column6     │ BIGINT      │ 0         │ 1885789678   │       1767602 │ 127166.98737165902 │ 4571867.453589752  │ 98      │ 717     │ 6760    │ 113607322 │            0.00 │
│ column7     │ BIGINT      │ 30        │ 183278402    │       1394313 │ 32408.302375721876 │ 376908.2117641157  │ 720     │ 2478    │ 10072   │ 113607322 │            0.00 │
└─────────────┴─────────────┴───────────┴──────────────┴───────────────┴────────────────────┴────────────────────┴─────────┴─────────┴─────────┴───────────┴─────────────────┘
Run Time (s): real 11.671 user 219.519242 sys 1.136306
```

Transferring data from DuckDB to PostgreSQL is straightforward and involves just two steps. First, you attach the remote PostgreSQL database and specify a remote schema name. Then, you import the data using "CREATE TABLE in PostgreSQL AS SELECT * FROM data file":



```
D ATTACH 'dbname=duckdb_test user=postgres host=postgres_container port=5432 password=postgres' AS pg_duckdb_test (TYPE postgres, SCHEMA 'public');
Run Time (s): real 0.627 user 0.394838 sys 0.082223
D CREATE TABLE pg_duckdb_test.custom_1988_2020 AS SELECT * FROM '/data/custom_1988_2020.csv';
100% ▕████████████████████████████████████████████████████████████▏
Run Time (s): real 88.547 user 36.957726 sys 2.746653
```

Credentials can be provided directly within the `ATTACH` command or managed through DuckDB's `CREATE SECRET` function. And in PostgreSQL we can see our new table:



```
duckdb_test=# \dS+ custom_1988_2020
                                               Table "public.custom_1988_2020"
 Column  |       Type        | Collation | Nullable | Default | Storage  | Compression | Stats target | Description
---------+-------------------+-----------+----------+---------+----------+-------------+--------------+-------------
 column0 | bigint            |           |          |         | plain    |             |              |
 column1 | bigint            |           |          |         | plain    |             |              |
 column2 | bigint            |           |          |         | plain    |             |              |
 column3 | bigint            |           |          |         | plain    |             |              |
 column4 | character varying |           |          |         | extended |             |              |
 column5 | bigint            |           |          |         | plain    |             |              |
 column6 | bigint            |           |          |         | plain    |             |              |
 column7 | bigint            |           |          |         | plain    |             |              |
Access method: heap

duckdb_test=# select count(*) from custom_1988_2020;
   count
-----------
 113607322
(1 row)
```

And that’s it! That’s the entire process for importing a 4.5 GB CSV file into PostgreSQL. The same method works for importing data into MySQL. This also works seamlessly with JSON and Parquet files, and hopefully, extensions for other data formats will be available soon.

After my tests, I really love DuckDB and I am convinced that it is an essential addition to the toolkit of any data scientist, data analyst, or database administrator. However, it is not a competitor to “big” databases; instead, it complements them by addressing weaknesses in areas that are often overlooked or underestimated.

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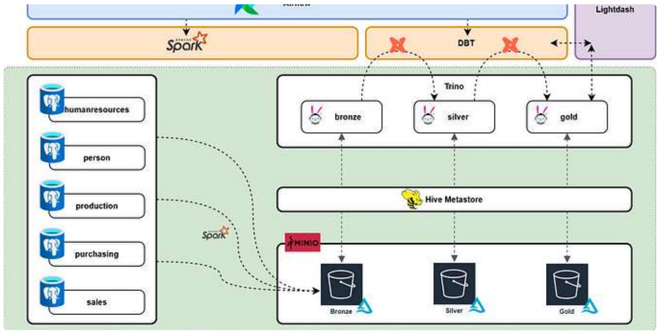

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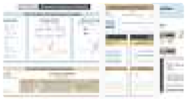

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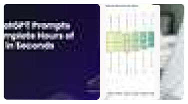

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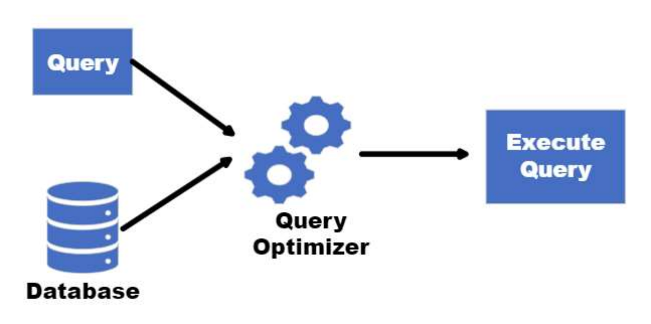

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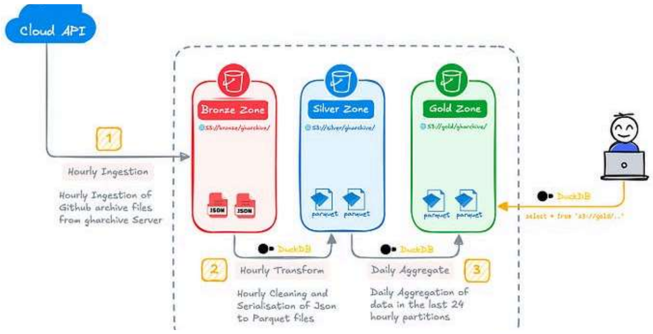

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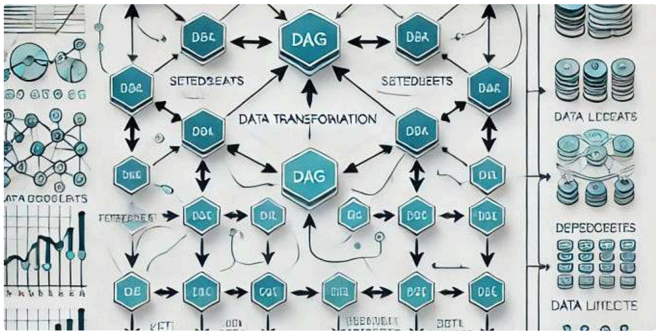

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