Exploring DuckDB potential

Josef Machytka
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This article serves as an introduction to my series on the DuckDB analytical database. In this series, I have so far published the following articles (listed from newest to oldest):

- PostgreSQL and DuckDB: Supercharging Ad-Hoc Data Analysis and ETL (with recorded online talk)
- DuckDB Performance Problems with Inappropriate Pivoting Queries on Very Large Datasets
- DuckDB Database File as a New Standard for Sharing Data?
- Data Exports to Parquet Format Using DuckDB
- Statistics and Histograms with DuckDB
- Pivot Tables with DuckDB
- Extending DuckDB ETL Capabilities with Python
- DuckDB as a Rudimentary Data Migration Tool
- Cross-Database Selects with DuckDB
- Using DuckDB as an Intelligent ETL tool for PostgreSQL
- How DuckDB handles data not fitting into memory?

How I Met DuckDB

My interest in DuckDB started during the PostgreSQL conference Swiss PG Day 2024. There, a big poster compared PostgreSQL and DuckDB, presenting this new tool as superior to my long-time favorite PostgreSQL database. Naturally, I was intrigued and decided to dig deeper, conducting some performance tests to see what DuckDB was truly capable of.

At first, my search led me to articles that felt overly hyped and disappointingly shallow. Many of them were so generic that replacing the word “DuckDB” with the name of another tool would leave the content practically unchanged. However, my perspective shifted when I discovered the e-book *DuckDB in Action* on the website motherduck.com. After diving into its main chapters, I became captivated by DuckDB’s potential.

DuckDB is not just another enthusiastic open-source project destined to fade away in six months because its creator loses interest. It was created at the National Research Institute for Mathematics and Computer Science in Amsterdam, which is also credited as a birthplace of the Python programming language.

Being familiar with PostgreSQL, I find it fascinating that DuckDB takes significant inspiration from PostgreSQL. It closely follows PostgreSQL SQL syntax, achieving it thanks to its use of a repackaged PostgreSQL SQL parser. This means that anyone familiar with PostgreSQL commands can immediately feel at home using DuckDB. Beyond this compatibility, DuckDB also introduces some really interesting innovative features, which I explore in details across my articles.

Importantly, DuckDB is not positioned as a competitor to traditional large-scale databases like PostgreSQL or MySQL. Instead, it occupies a unique niche as an embedded analytical database optimized for heavy parallel analytical workloads, leveraging its vectorized query engine. Remarkably, it can efficiently process very large datasets — even those not fitting into memory. I believe DuckDB holds significant promise as a complementary tool to established databases, as well as to modern data infrastructures like Data Lakes and Lakehouses. Let’s explore its potential deeper.

Image created by the author using DeepDreamGenerator

Postgresql Duckdb Data Analysis Etl Tool

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I work as PostgreSQL specialist & database reliability engineer at NetApp Deutschland, Open Source Services division.

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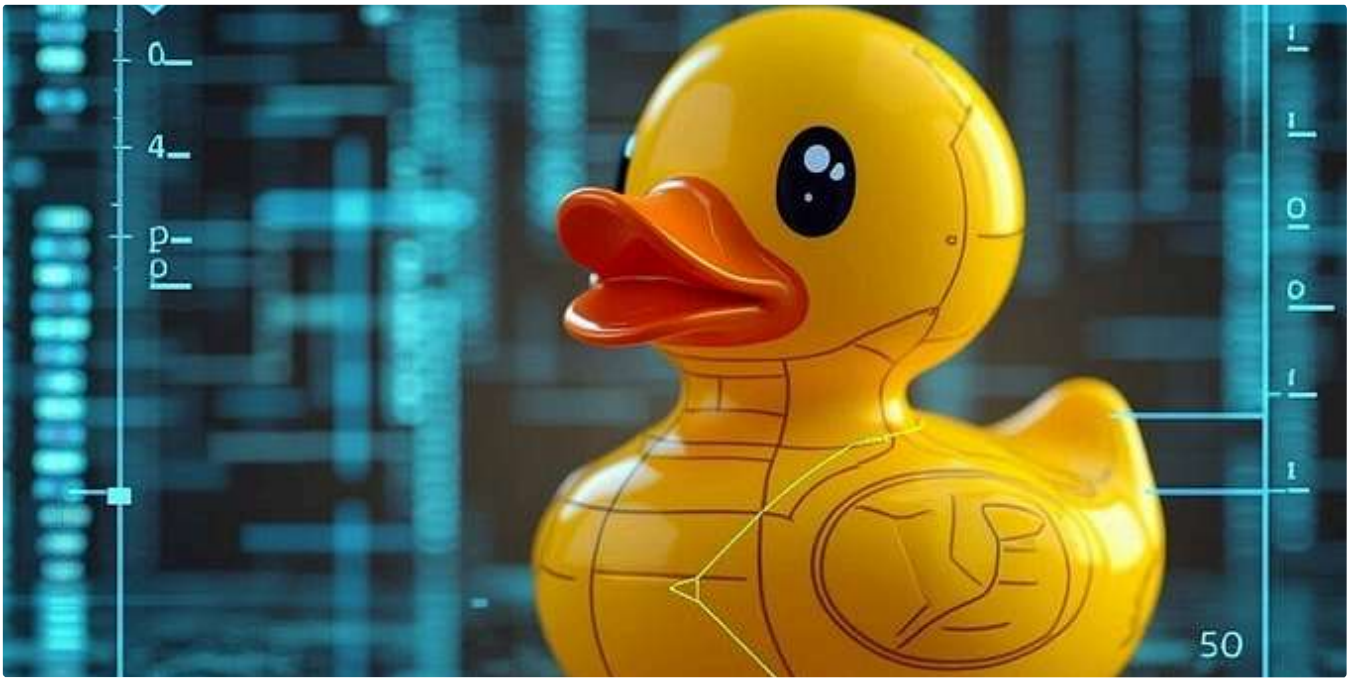

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DuckDB Database File as a New Standard for Sharing Data?

This is not my original idea; I came across it in an excellent article titled “DuckDB Beyond the Hype” by Alireza Sadeghi. However, it...

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probe_id int64	2024-12-18_avg_tem… double	2024-12-19_avg_tem… double	2024-12-20_avg_tem… double	2024-12-21_avg_tem… double	…	2024-12-27_avg_tem… double	2024-12-28_avg_tem… double	2024-12-29_avg_tem… double	2024-12-30_avg_tem… double
1	-0.09333333333333331	0.008709499040937112	-0.09530979615314230	0.010285515229008652	…	0.024082900616364426	-0.06485498315668406	0.012230606453306028	2.89
2	-1.8681481481481474	-0.011747858418378…	-0.19133368175211093	-0.06350527768649375	…	-0.04171747826158102	-0.02843359476698743	-0.025157060000087…	-31.82
3	0.5514285714285712	0.03776647082685746	0.27300376356349165	0.14048107877274826	…	0.011376852696737617	0.0502324666659877	0.08683195299201234	-3.990000000000001
4	0.15520325203252047	-0.008692187717719168	0.08583476862546609	-0.061396022144761 16	…	0.19196071702861273	-0.08186630396370788	0.08936674686468202	19.36
5	0.5163888888888885	-0.045700490736644817	0.01953642221439854	-0.015551540087672…	…	-0.01359002275741 25	-0.07238289422942779	-0.18353784234809068	
6	1.0165486725663717	0.029071114059955196	0.08107486316960297	0.017795231646764362	…	0.11904802583941525	0.04725992074913865	0.08915156107911504	-27.380000000000003
7	0.07568807339449547	0.14391917325689826	0.05512613147262228	-0.09983962752198643	…	0.16227462051478873	-0.15890324113132445	-0.05464776857339331	
8	2.034600000000001	0.11482386883886646	0.09522098292944779	0.062771995286724 14	…	0.10036929933070622	0.13754822380761314	-0.05208855536214023	17.05
9	1.5455856179775286	0.09855607778079753	-0.03765412237862671	0.04697267741617703	…	-0.06521116188527977	-0.0032089106887395…	0.06777951553103001	-19.71
10	-0.6838000000000001	-0.28492896786129136	-0.08407264992227768	-0.05535888615888 6…	…	0.061434627070469434	0.08977096362267186	0.07613119220133417	-13.08
11	-3.7764347826086957	-0.10416217933853829	0.07367137134759187	0.18342240982852617	…	0.04691991417919546	0.0842402263416545	0.07204996928117939	-19.3
12	3.520606060606606	0.2100927168344198	0.18093850718864263	-0.055756935746621 55	…	0.06861218940928169	-0.0077779324699063…	0.03938419688864 1266	45.96
13	-0.44719626168224432	-0.04059024910542247	0.05239493131063208	-0.021405589594085 01	…	-0.01592269770570314	0.07835466119365161	-0.03261512269386271	4.923333333333334
14	-2.001339285714285 8	0.07316068336385598	-0.05005799448684 42…	-0.022370491099405826	…	0.03994954500485442 6	0.07726930817610073	-0.03379195482260548	-1.7650000000000006
15	-2.209239313043478 27	-0.00514496682415 5…	-0.05662676811376 70…	0.08211320367634989 29	…	-0.0502924418318254	0.05335375404928863	0.06826877209785106	5.020000000000005
16	-5.104608695652175	-0.18033826233814361	0.01292838487297233 4	-0.0595786342858545…	…	0.09010858405407832	0.03176688704763877	-0.00866681223794503	20.44
17	4.781382978723406	0.06598824767680733	0.16312028213207262	-0.07717668773888778	…	0.03365020383722565	0.0891822301972314	0.09128568507993609	-13.65
18	0.09867256637168122	-0.00259735235966 6…	0.03803206675119623 3	0.05646905735349664 5	…	-0.0561575135985831…	0.04528215540037215	-0.07462724619622213	
19	2.0930851063829783	-0.01148322710644 8…	-0.02934949084170585	-0.12917833341526482	…	0.09808158720020972	-0.06237591444411659	-0.14364666680662121	
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982	4.146236559139785	-0.00621086647346 6…	-0.12709462668479013	0.07320853030092017	…	0.1600774813251191	0.0847571846019098	0.06076915535876202 5	45.92
983	-2.2424489795918374	0.1292289729655479	-0.03578956372968345	-0.11036742167256543	…	0.09850752882287772	0.08381679949749958	0.1301149031511466	26.12
984	-4.861891891891899	-0.01495983417621 3…	-0.06395120195650242	0.10667740909053837	…	0.04613073286371114	0.18371431376077715	-0.10319072996226 13	9.035
985	-1.8353846153846156	0.003296385458702291	0.09753330664989428	0.14356711686992685	…	0.1461250838808932	0.04264527854992811	0.04525775774073553 54	45.31
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990	-4.490602409638554	0.012684438773310816	0.13265936665410001	-0.16057133716685 68	…	0.03820050655322511	-0.01058317870572 6…	-0.02406956821144 2…	2.5549999999999997
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DuckDB Performance Problems with Inappropriate Pivoting Queries on Very Large Datasets

The DuckDB documentation clearly states that this tool is designed for handling datasets fitting into memory. I fully understand that I'm…

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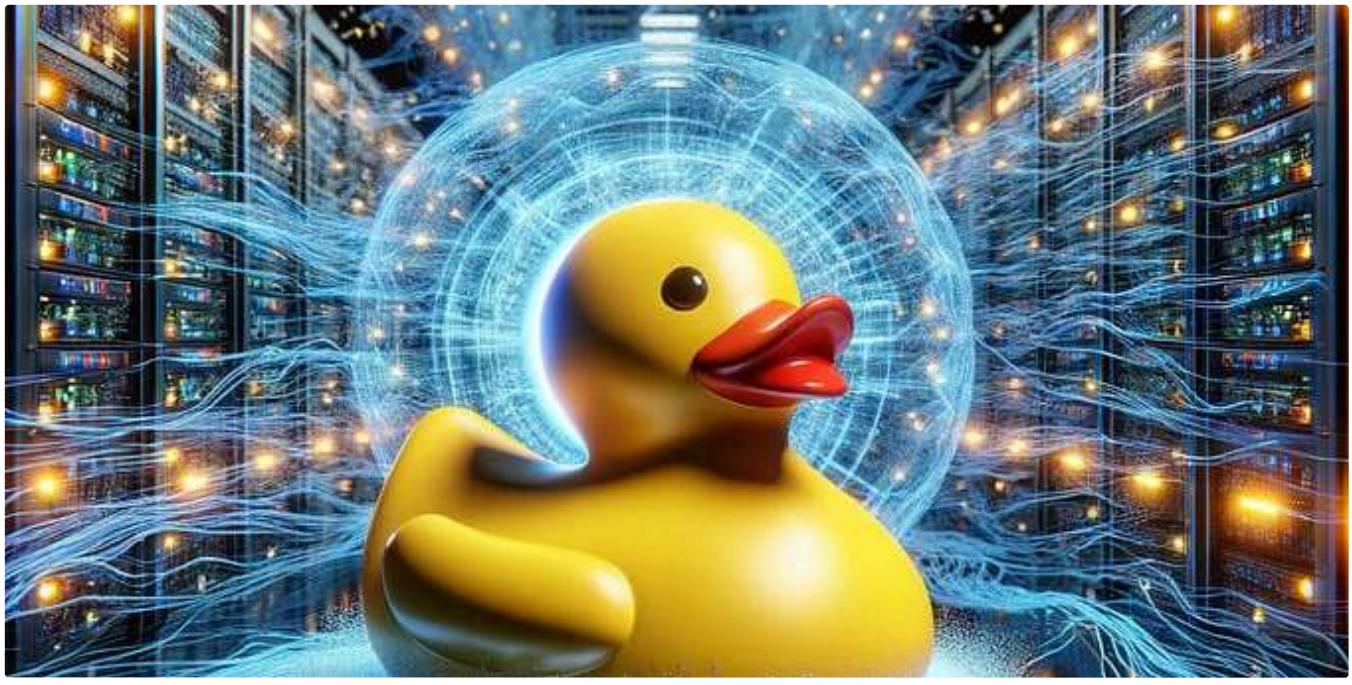

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Quick and Easy Data Exports to Parquet Format Using DuckDB

The Parquet format has become almost an industry standard for Data Lakes and Data Lakehouses, thanks to its efficiency and compact storage...

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```
ate the table
 TABLE special_data_types (
 INT AUTO_INCREMENT PRIMARY KEY,
me VARCHAR(50) NOT NULL,
atus ENUM('active', 'inactive', 'pending') NOT NULL,
rmissions SET('read', 'write', 'execute') NOT NULL,
all_number TINYINT NOT NULL,
dium_number MEDIUMINT NOT NULL,
scription TEXT,
ta BLOB,
eated_at DATE NOT NULL


ert 10 rows of data
 INTO special_data_types (name, status, permissions, small_number, medium_number, description, data, created_at)
e', 'active', 'read,write', 5, 1000, 'Alice description', 'Alice data', '2023-01-01'),
, 'inactive', 'read', 10, 2000, 'Bob description', 'Bob data', '2023-02-01'),
lie', 'pending', 'write,execute', 15, 3000, 'Charlie description', 'Charlie data', '2023-03-01'),
d', 'active', 'read,write,execute', 20, 4000, 'David description', 'David data', '2023-04-01'),
, 'inactive', 'execute', 25, 5000, 'Eve description', 'Eve data', '2023-05-01'),
k', 'pending', 'read,write', 30, 6000, 'Frank description', 'Frank data', '2023-06-01'),
e', 'active', 'read', 35, 7000, 'Grace description', 'Grace data', '2023-07-01'),
', 'inactive', 'write,execute', 40, 8000, 'Hank description', 'Hank data', '2023-08-01'),
, 'pending', 'read,write,execute', 45, 9000, 'Ivy description', 'Ivy data', '2023-09-01'),
'. 'active', 'execute', 50, 10000, 'Jack description', 'Jack data', '2023-10-01');
```

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DuckDB as a Rudimentary Data Migration Tool

After exploring how to use DuckDB as an intelligent ETL tool for PostgreSQL, and how to extend its ETL capabilities with simple Python...

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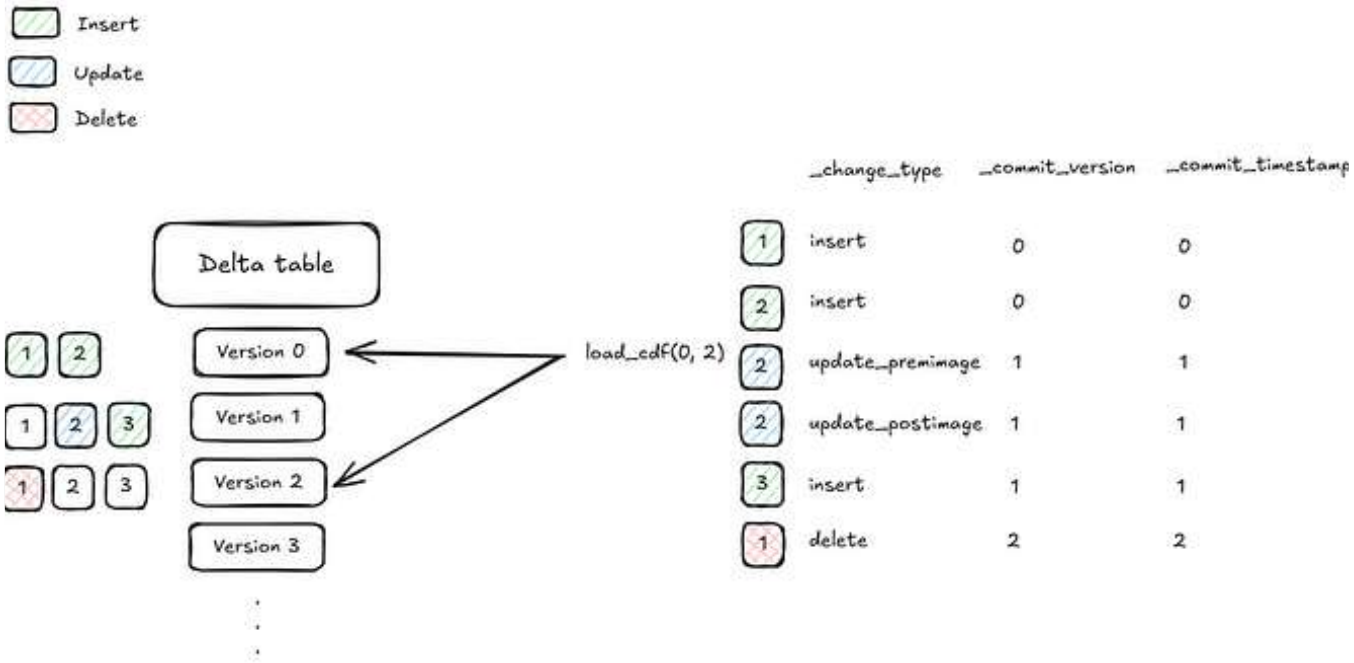

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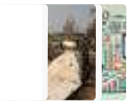

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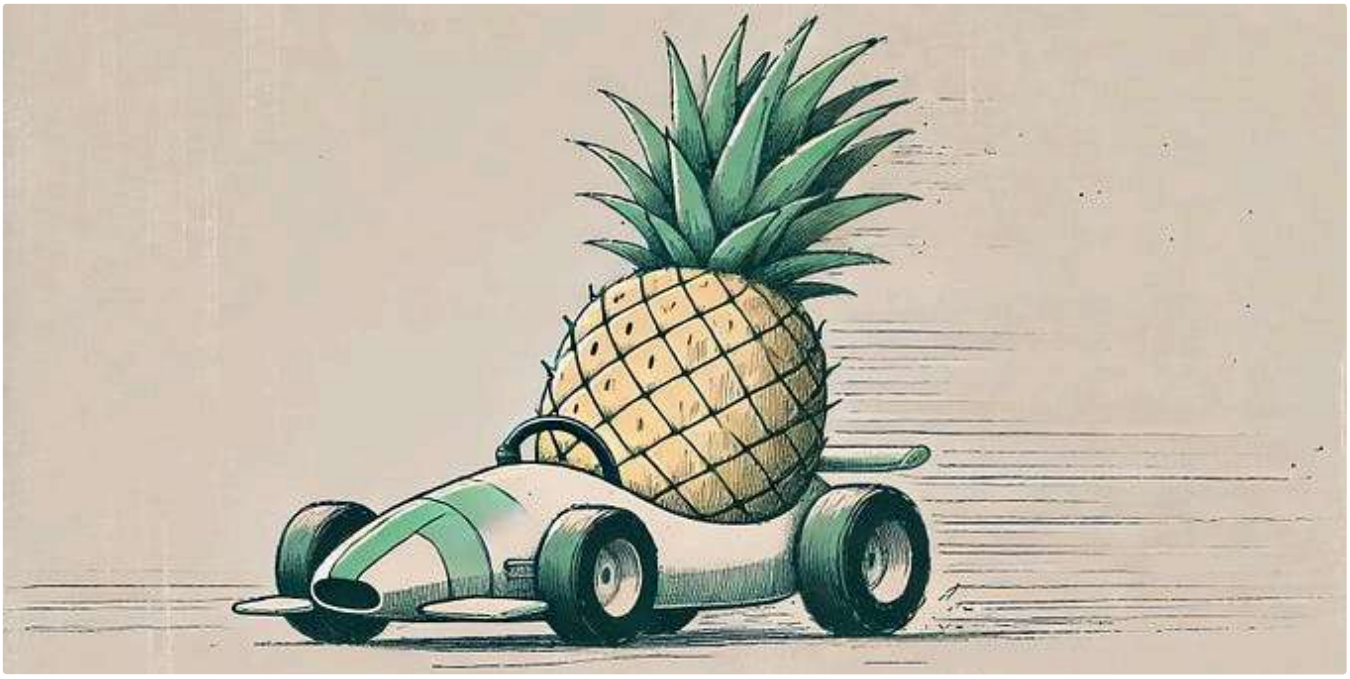

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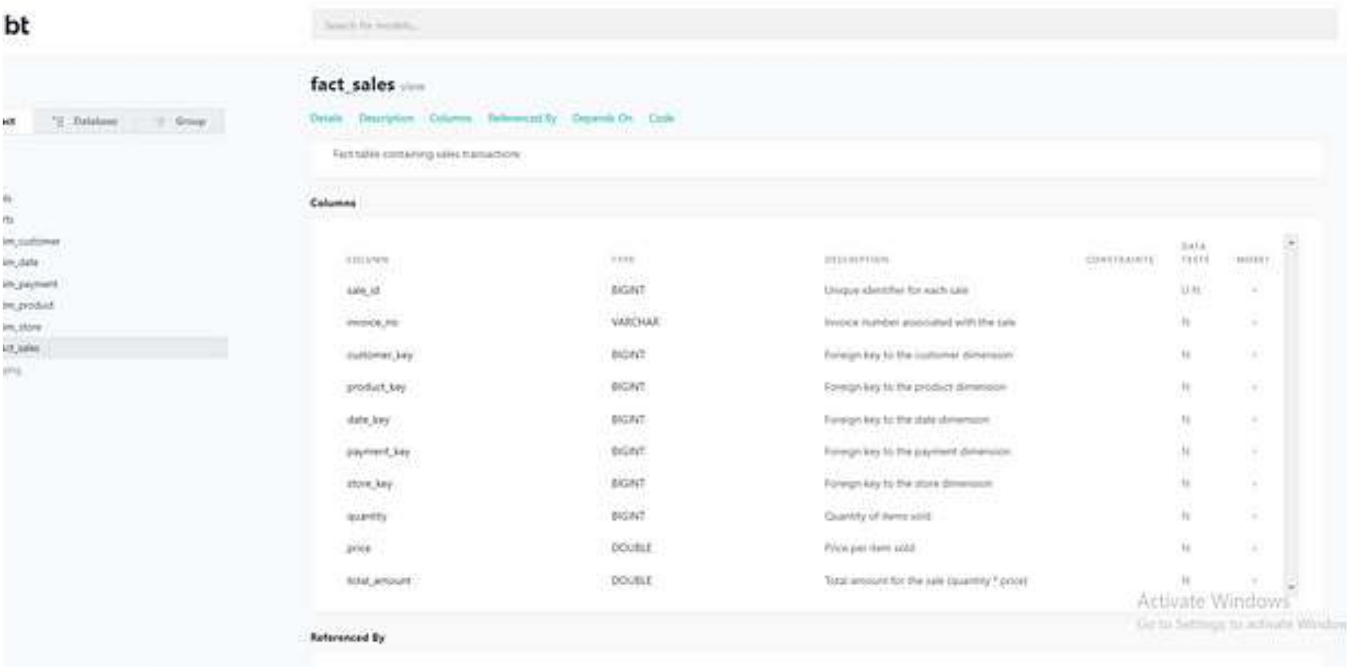

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