Vertica Knowledge Base Article

Data Transformation Solution with dbt and Vertica using the dbt-vertica Adapter

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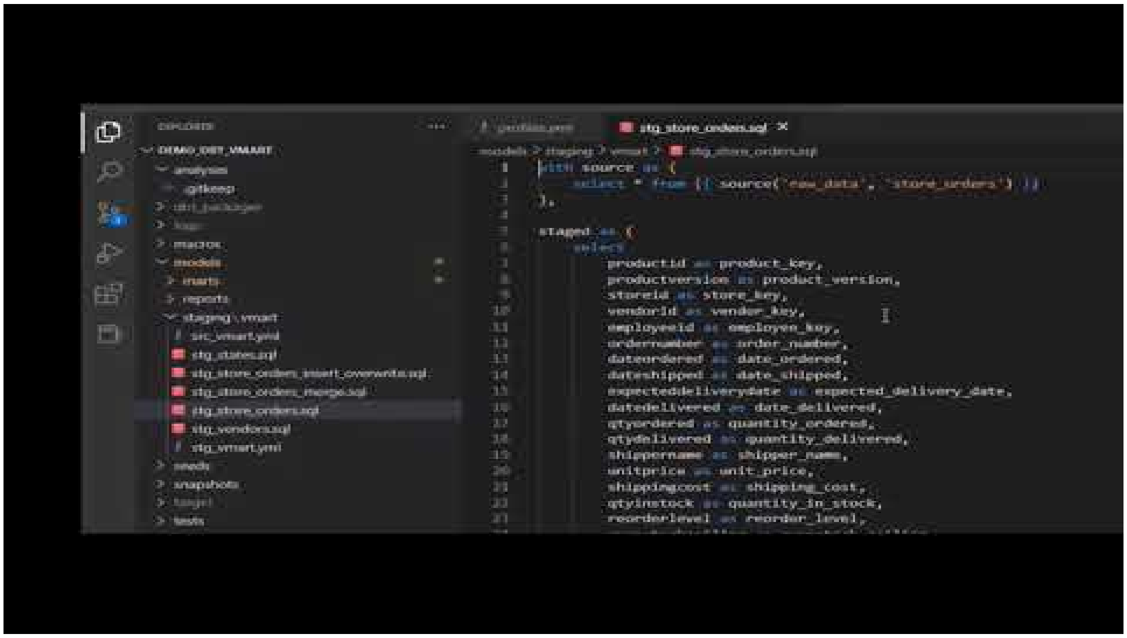
End-To-End Data Transformation Guide: Using the dbt-vertica Adapter for Analytics

This video explains the integration of dbt and Vertica using the open-source dbt-vertica-adapter. Check out the video to understand how you can quickly transform your raw data directly in Vertica and take advantage of the new features in the adapter.



```
with source as (
    select * from {{ source('raw_data', 'store_orders') }}
),

staged as (
    select
        productid as product_key,
        productversion as product_version,
        storeid as store_key,
        vendorid as vendor_key,
        employeeid as employee_key,
        ordernumber as order_number,
        dateordered as date_ordered,
        dateshipped as date_shipped,
        expecteddeliverydate as expected_delivery_date,
        datedelivered as date_delivered,
        qtyordered as quantity_ordered,
        qtydelivered as quantity_delivered,
        shippername as shipper_name,
        unitprice as unit_price,
        shippingcost as shipping_cost,
        qtyinstock as quantity_in_stock,
        reorderlevel as reorder_level,
```

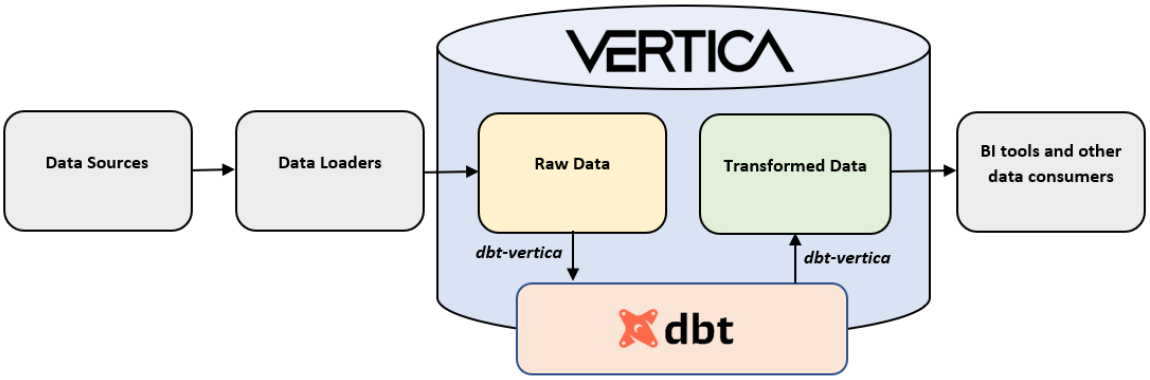
dbt or Data Build Tool, is a data transformation tool that streamlines the process of transforming raw data into curated data sets that are clean, easy to query, and ready for analysis. In dbt, data transformations and business logic are expressed using SQL statements and Jinja language. Jinja turns dbt into a programing environment for SQL.

You can use dbt and OpenText™ Vertica™ to build a robust and efficient data transformation pipeline. dbt code is processed in-database leveraging Vertica's high performance. In addition, dbt provides software development best practices such as, version control, built-in testing framework, documentation, and code reusability that allows SQL developers to work like Software Engineers.

The dbt adapter for Vertica enables the connection to Vertica from dbt. dbt-vertica is an open-source project available in Vertica's GitHub repository. It is written in Python and yml, and uses the vertica-python driver.

Vertica + dbt Data Stack

This is a diagram of dbt and Vertica data stack. dbt transforms data that is already loaded into Vertica and uses the dbt-vertica adapter to connect to your database. Unlike traditional data transformation tools, dbt data transformations are executed directly in your database. No data is transferred out of Vertica. The transformed data can then be used by BI tools and other technologies for further analysis.



Solution Overview

This document provides an example of a data transformation pipeline using VMart and includes the steps to configure the environment and connect to Vertica using the dbt-vertica adapter.

The solution presented in this document is categorized in the following sections:

- "Scope" below
- "Environment" on the next page
- "Configuring the Environment to Use dbt with Vertica" on the next page
- "Configuring a dbt Profile to Connect to Vertica" on page 9
- "Example of a Data Transformation Pipeline Using VMart" on page 11
- "Summary and Conclusions" on page 34

You can expand and collapse topics for more details as you go along reading the guide.

Scope

Familiarity with dbt-core, Vertica, SQL, Jinja, and VS Code is required and assumed.

This document **does not** cover

- Installation of Vertica and the VMart database.
- Data loading: The process to load the raw data into Vertica.

- Data visualization: The steps to visualize the transformed data.
- dbt cloud.

Environment

This is the environment we used to execute the examples in this document:

> Important dbt-core and vertica-python are automatically installed when you install the dbt-vertica adapter.

Vertica environment:

- Vertica Analytical Database 23.3.0 installed on a 3-node Linux VM cluster.
- VMart example database

dbt environment on Windows:

- Visual Studio Code (vscode) version 1.76.2
- git version 2.40.0
- python version 3.11.2
- dbt-vertica adapter version 1.5.0
- vertica-python driver version 1.3.1
- dbt-core version 1.5.0

A database SQL client that can connect to the database:

- In our testing, we used DBVisualizer version 13.0.4 to examine the data in tables or views in a user-friendly manner.

Configuring the Environment to Use dbt with Vertica

This section explains how to install the dbt-vertica adapter and initialize a dbt project. The configuration is based on a Windows environment.

Prerequisites

Ensure you have installed the following before you begin:

- python
- git

  > Note git is recommended to incorporate source control in your dbt project. This is a best practices. Make sure to add an entry of the location of git.exe to the user’s path environment variable.

- Visual Studio Code (VS Code)
- VS Code Python extension

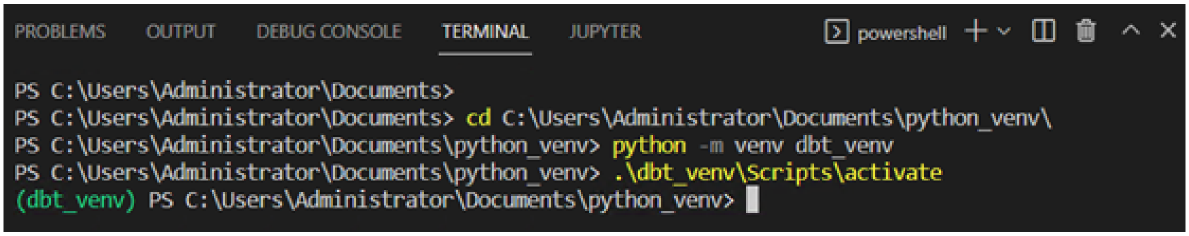
Installing the dbt-vertica adapter

Follow these steps to install the adapter on Windows:

1. Open VS Code.
2. In the **Terminal** menu at the top of the screen, click **New Terminal**.
3. The command line interface CLI opens up.
4. Create and activate a Python Virtual Environment.

> Note We recommend you to install the adapter and create your dbt project in this isolated environment.

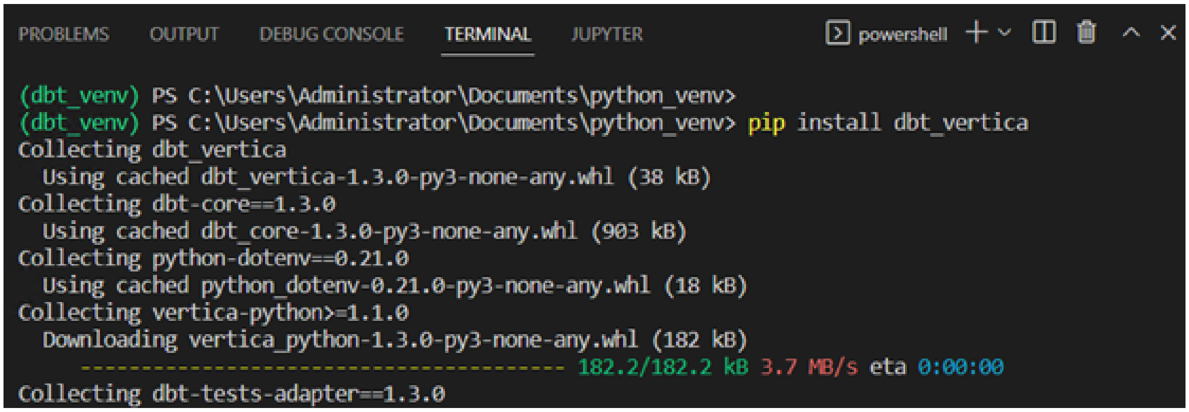
5. Move to the folder where you want to create your virtual environment, and create and activate your environment:



```
PS C:\Users\Administrator\Documents>
PS C:\Users\Administrator\Documents> cd C:\Users\Administrator\Documents\python_venv\
PS C:\Users\Administrator\Documents\python_venv> python -m venv dbt_venv
PS C:\Users\Administrator\Documents\python_venv> .\dbt_venv\Scripts\activate
(dbt_venv) PS C:\Users\Administrator\Documents\python_venv>
```

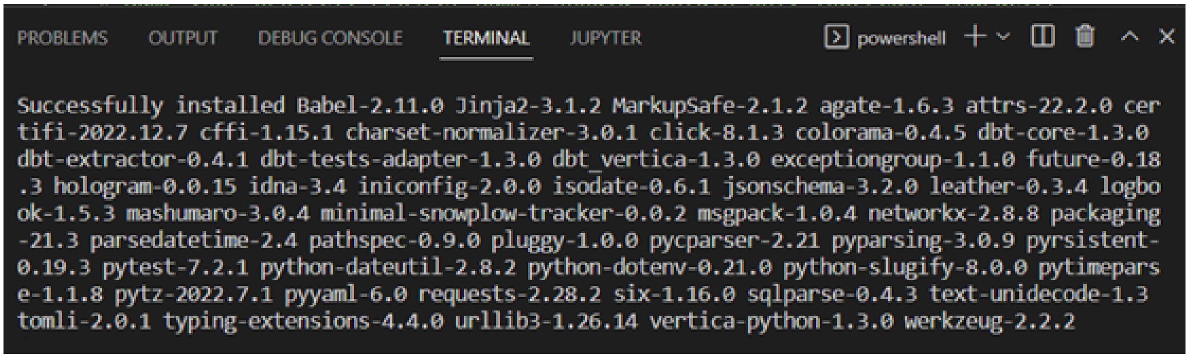
6. Run a pip install dbt-vertica to install the adapter:

> Note This action installs dbt-core and vertica-python, you do not need to install them separately.



```
(dbt_venv) PS C:\Users\Administrator\Documents\python_venv>
(dbt_venv) PS C:\Users\Administrator\Documents\python_venv> pip install dbt_vertica
Collecting dbt_vertica
  Using cached dbt_vertica-1.3.0-py3-none-any.whl (38 kB)
Collecting dbt-core==1.3.0
  Using cached dbt_core-1.3.0-py3-none-any.whl (903 kB)
Collecting python-dotenv==0.21.0
  Using cached python_dotenv-0.21.0-py3-none-any.whl (18 kB)
Collecting vertica-python>=1.1.0
  Downloading vertica_python-1.3.0-py3-none-any.whl (182 kB)
     ---------------------------------------- 182.2/182.2 kB 3.7 MB/s eta 0:00:00
Collecting dbt-tests-adapter==1.3.0
```

The log should end with the list of packages that got installed like this:

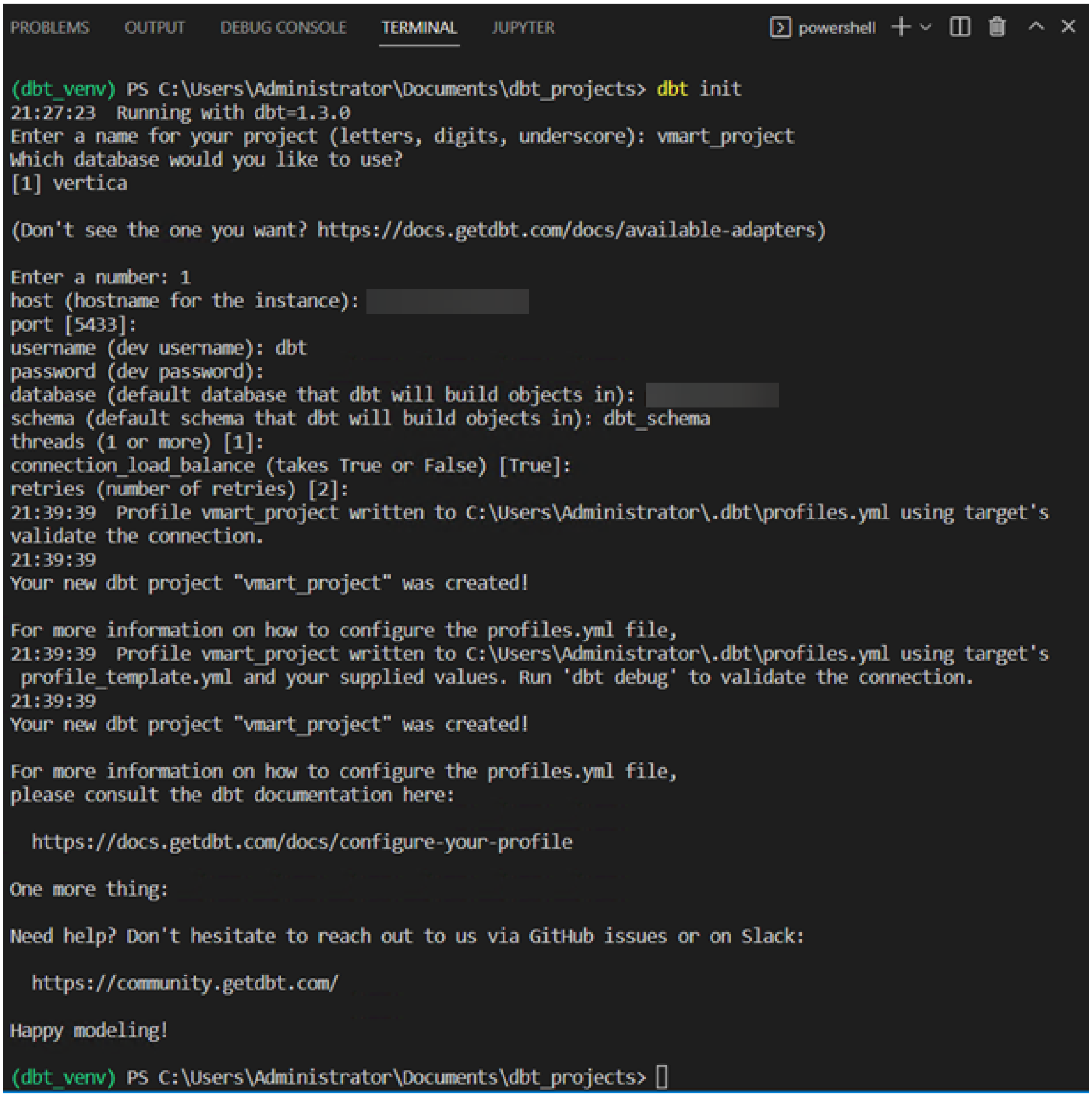


```
Successfully installed Babel-2.11.0 Jinja2-3.1.2 MarkupSafe-2.1.2 agate-1.6.3 attrs-22.2.0 cer
tifi-2022.12.7 cffi-1.15.1 charset-normalizer-3.0.1 click-8.1.3 colorama-0.4.5 dbt-core-1.3.0
dbt-extractor-0.4.1 dbt-tests-adapter-1.3.0 dbt_vertica-1.3.0 exceptiongroup-1.1.0 future-0.18
.3 hologram-0.0.15 idna-3.4 iniconfig-2.0.0 isodate-0.6.1 jsonschema-3.2.0 leather-0.3.4 logbo
ok-1.5.3 mashumaro-3.0.4 minimal-snowplow-tracker-0.0.2 msgpack-1.0.4 networkx-2.8.8 packaging
-21.3 parsedatetime-2.4 pathspec-0.9.0 pluggy-1.0.0 pycparser-2.21 pyparsing-3.0.9 pyrsistent-
0.19.3 pytest-7.2.1 python-dateutil-2.8.2 python-dotenv-0.21.0 python-slugify-8.0.0 pytimepars
e-1.1.8 pytz-2022.7.1 pyyaml-6.0 requests-2.28.2 six-1.16.0 sqlparse-0.4.3 text-unidecode-1.3
tomli-2.0.1 typing-extensions-4.4.0 urllib3-1.26.14 vertica-python-1.3.0 werkzeug-2.2.2
```

Initializing Your dbt Project

Follow these steps to initialize the dbt project that will host your transformation models:

1. Create a folder to host the dbt project and run the **dbt init** command to create the project in this location. Enter the information requested in the CLI:



```
(dbt_venv) PS C:\Users\Administrator\Documents\dbt_projects> dbt init
21:27:23  Running with dbt=1.3.0
Enter a name for your project (letters, digits, underscore): vmart_project
Which database would you like to use?
[1] vertica

(Don't see the one you want? https://docs.getdbt.com/docs/available-adapters)

Enter a number: 1
host (hostname for the instance): [redacted]
port [5433]:
username (dev username): dbt
password (dev password):
database (default database that dbt will build objects in): [redacted]
schema (default schema that dbt will build objects in): dbt_schema
threads (1 or more) [1]:
connection_load_balance (takes True or False) [True]:
retries (number of retries) [2]:
21:39:39  Profile vmart_project written to C:\Users\Administrator\.dbt\profiles.yml using target's
validate the connection.
21:39:39
Your new dbt project "vmart_project" was created!

For more information on how to configure the profiles.yml file,
21:39:39  Profile vmart_project written to C:\Users\Administrator\.dbt\profiles.yml using target's
 profile_template.yml and your supplied values. Run 'dbt debug' to validate the connection.
21:39:39
Your new dbt project "vmart_project" was created!

For more information on how to configure the profiles.yml file,
please consult the dbt documentation here:

  https://docs.getdbt.com/docs/configure-your-profile

One more thing:

Need help? Don't hesitate to reach out to us via GitHub issues or on Slack:

  https://community.getdbt.com/

Happy modeling!

(dbt_venv) PS C:\Users\Administrator\Documents\dbt_projects> 
```

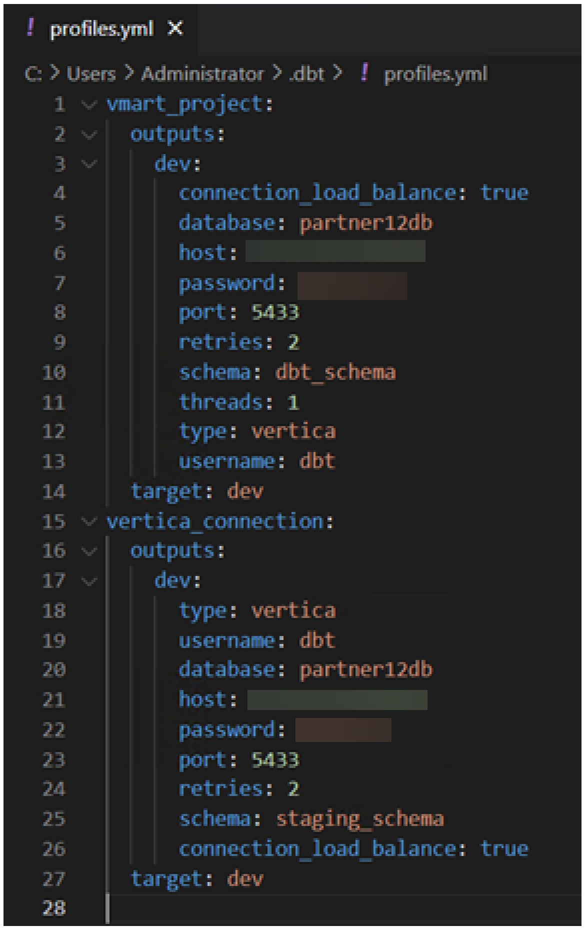
> Note This action creates a skeleton project with all the necessary empty folders. It also creates the profile file you can edit to connect to Vertica. The dbt project file **dbt_project.yml** contains the project configuration.

Configuring a dbt Profile to Connect to Vertica

This section explains how you can configure the connection to Vertica also known as the dbt profile. The dbt profiles file is generated automatically when you initialize a project as described in the previous section. The dbt profiles file is in the following directory: C:\Users\<my_user>\.dbt\profiles.yml.

Specifying the Connection to Vertica

Below is an example of the profiles file **profiles.yml**. You can edit the profiles file and add multiple connections identified by a unique name. The connection you used in your project is specified in the project configuration file **dbt_project.yml**.

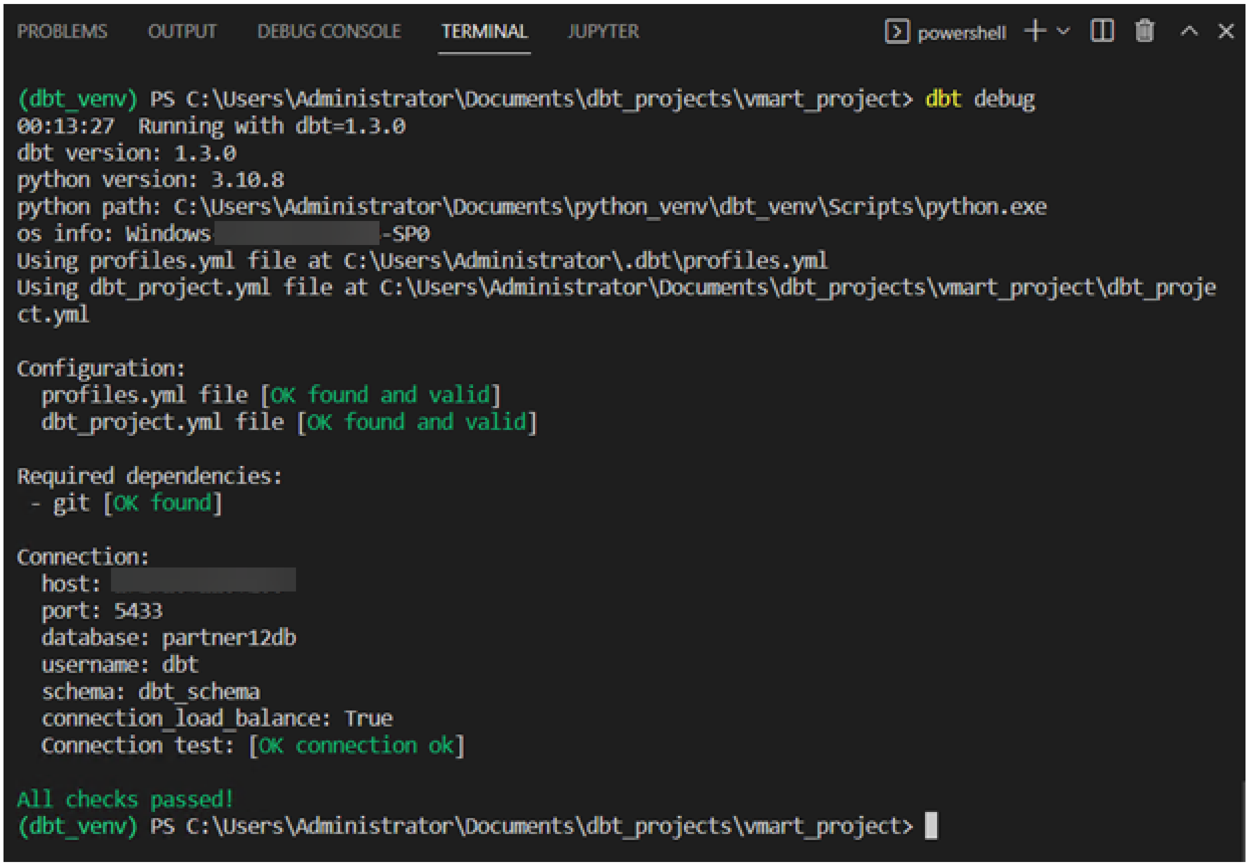


```yaml
vmart_project:
  outputs:
    dev:
      connection_load_balance: true
      database: partner12db
      host: [redacted]
      password: [redacted]
      port: 5433
      retries: 2
      schema: dbt_schema
      threads: 1
      type: vertica
      username: dbt
  target: dev
vertica_connection:
  outputs:
    dev:
      type: vertica
      username: dbt
      database: partner12db
      host: [redacted]
      password: [redacted]
      port: 5433
      retries: 2
      schema: staging_schema
      connection_load_balance: true
  target: dev

```

Testing the Connection to Vertica

Execute the **dbt debug** command to test your connection to Vertica. This command should be run with the Python virtual environment active and inside the folder of your dbt project.

> Note **dbt debug** checks that python and all .yml files have been configured correctly and that dbt is able to reach Vertica using the connection information provided in the profiles.yml file.



```
(dbt_venv) PS C:\Users\Administrator\Documents\dbt_projects\vmart_project> dbt debug
00:13:27  Running with dbt=1.3.0
dbt version: 1.3.0
python version: 3.10.8
python path: C:\Users\Administrator\Documents\python_venv\dbt_venv\Scripts\python.exe
os info: Windows [redacted]-SP0
Using profiles.yml file at C:\Users\Administrator\.dbt\profiles.yml
Using dbt_project.yml file at C:\Users\Administrator\Documents\dbt_projects\vmart_project\dbt_proje
ct.yml

Configuration:
  profiles.yml file [OK found and valid]
  dbt_project.yml file [OK found and valid]

Required dependencies:
 - git [OK found]

Connection:
  host: [redacted]
  port: 5433
  database: partner12db
  username: dbt
  schema: dbt_schema
  connection_load_balance: True
  Connection test: [OK connection ok]

All checks passed!
(dbt_venv) PS C:\Users\Administrator\Documents\dbt_projects\vmart_project> █
```

When all tests have passed, you are ready to start building your dbt models.

Example of a Data Transformation Pipeline Using VMart

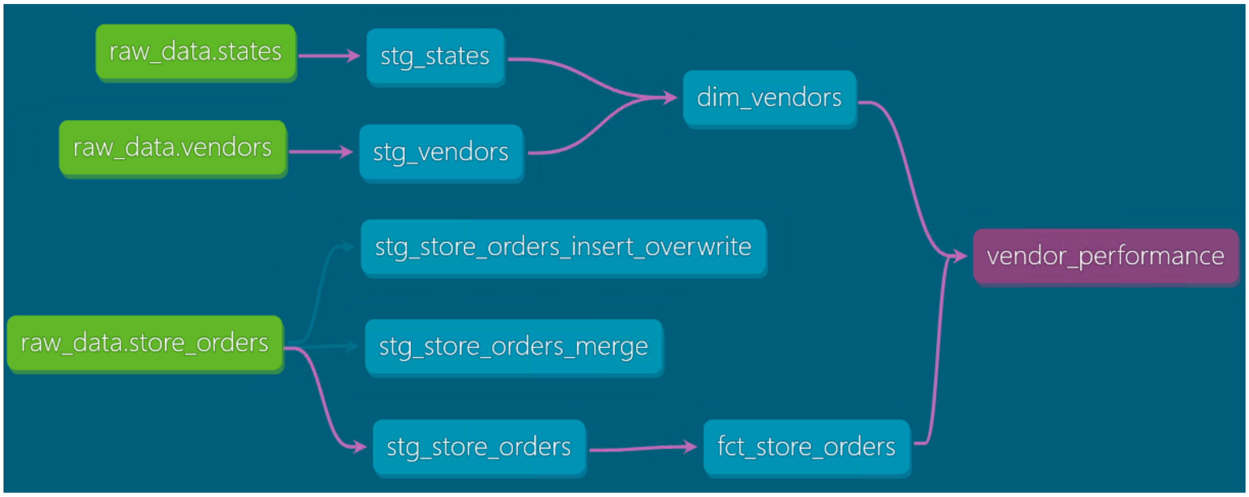
The following solution consists of a data transformation pipeline with the purpose of business analytics and reporting. We want to calculate the **on-time delivery rate**, **quantity accuracy rate**, and the **perfect order rate** by vendor. We will call this final model **vendor_performance**. We will show how the **vendor_performance** model is created throughout a series of transformation steps that begin with the raw data.

Project Lineage Graph

This is the Lineage graph of the solution. It represents the flow of data from source to final model:

- The green nodes are the sources/raw data that we use in this project.
- The second level of nodes are the staging models that reference the sources and slightly transform the raw data.
- Third level of nodes are the models that reference the staging models and apply business logic to transform them. In this case a dimension and a fact table. Users might query these models using a BI tool.

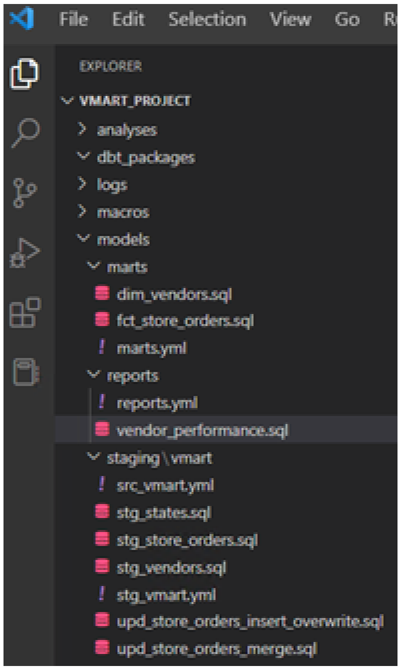
- Last node is the final model that uses both the fact table and the dimension table and calculates Vendor KPIs for reporting.



Project Organization

The project is organized using the following folder structure:

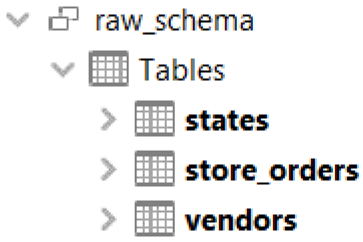
- **staging**: Contains the models that reference the raw data tables and slightly transform them.
- **marts > vmart**: Contains the models that reference the staging models and apply business logic to further transform them.
- **reports**: Contains the final models that end-users may query for analysis.



```
VMART_PROJECT
  analyses
  dbt_packages
  logs
  macros
  models
    marts
      dim_vendors.sql
      fct_store_orders.sql
      marts.yml
    reports
      reports.yml
      vendor_performance.sql
    staging \ vmart
      src_vmart.yml
      stg_states.sql
      stg_store_orders.sql
      stg_vendors.sql
      stg_vmart.yml
      upd_store_orders_insert_overwrite.sql
      upd_store_orders_merge.sql
```

Specifying the Source

The source is the raw data that we process in the project. The source file for this project is **src_vmart.yml** in the **models > staging > vmart** directory. This file documents and specifies the tests for the following raw tables: **raw_schema.states**, **raw_schema.vendors**, and **raw_schema.store_orders**:



raw_schema
Tables
states
store_orders
vendors

> Note You can use Vertica's built-in functionality or various complementary technologies to bring source data into your database. Source data along with ddl files reside in the `demo_dbt_vmart/sampledata` directory. The raw data used in this project has been already loaded into Vertica.

models > staging > vmart > src_vmart.yml

```
version: 2

sources:
  - name: raw_data
    description: This is the raw data to transform.
    database: partner12db
    schema: raw_schema
    tables:
      - name: states
        description: This is the raw states data.
        columns:
          - name: statecode
            description: The primary key for the raw states data.
            tests:
              - unique
              - not_null

      - name: vendors
        description: This is the raw vendors data.
        columns:
          - name: vendorid
            description: The primary key for the raw vendors data.
            tests:
              - unique
              - not_null

      - name: store_orders
        description: This is the raw store_orders data.
        columns:
          - name: ordernumber
            description: The primary key for the raw store_orders data.
            tests:
              - unique
              - not_null
```

This is what the data looks like for each raw table. The images display only the first 10 rows of data:

raw_schema.states:

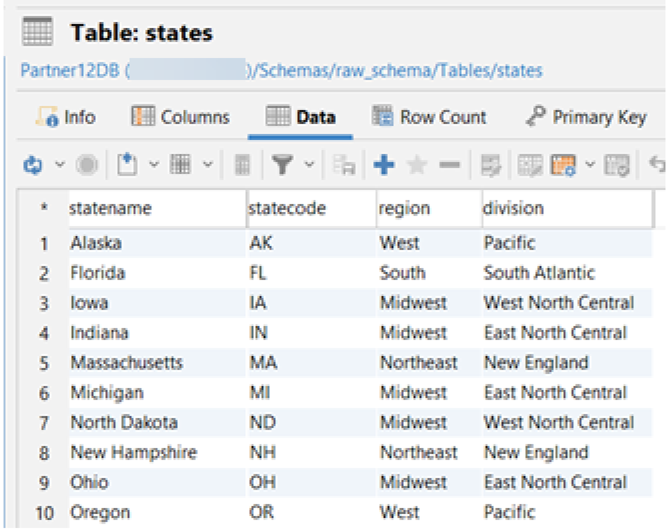


Table: states

Partner12DB ([redacted])/Schemas/raw_schema/Tables/states

*	statename	statecode	region	division
1	Alaska	AK	West	Pacific
2	Florida	FL	South	South Atlantic
3	Iowa	IA	Midwest	West North Central
4	Indiana	IN	Midwest	East North Central
5	Massachusetts	MA	Northeast	New England
6	Michigan	MI	Midwest	East North Central
7	North Dakota	ND	Midwest	West North Central
8	New Hampshire	NH	Northeast	New England
9	Ohio	OH	Midwest	East North Central
10	Oregon	OR	West	Pacific

raw_ schema.vendors:

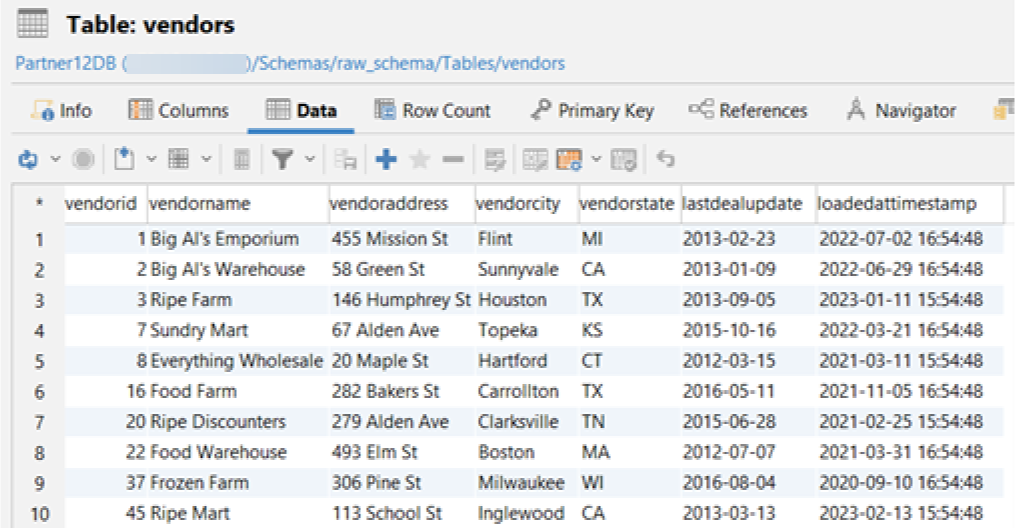


Table: vendors

Partner12DB ([redacted])/Schemas/raw_schema/Tables/vendors

*	vendorid	vendorname	vendoraddress	vendorcity	vendorstate	lastdealupdate	loadedattimestamp
1	1	Big Al's Emporium	455 Mission St	Flint	MI	2013-02-23	2022-07-02 16:54:48
2	2	Big Al's Warehouse	58 Green St	Sunnyvale	CA	2013-01-09	2022-06-29 16:54:48
3	3	Ripe Farm	146 Humphrey St	Houston	TX	2013-09-05	2023-01-11 15:54:48
4	7	Sundry Mart	67 Alden Ave	Topeka	KS	2015-10-16	2022-03-21 16:54:48
5	8	Everything Wholesale	20 Maple St	Hartford	CT	2012-03-15	2021-03-11 15:54:48
6	16	Food Farm	282 Bakers St	Carrollton	TX	2016-05-11	2021-11-05 16:54:48
7	20	Ripe Discounters	279 Alden Ave	Clarksville	TN	2015-06-28	2021-02-25 15:54:48
8	22	Food Warehouse	493 Elm St	Boston	MA	2012-07-07	2021-03-31 16:54:48
9	37	Frozen Farm	306 Pine St	Milwaukee	WI	2016-08-04	2020-09-10 16:54:48
10	45	Ripe Mart	113 School St	Inglewood	CA	2013-03-13	2023-02-13 15:54:48

raw_ schema.store_orders:

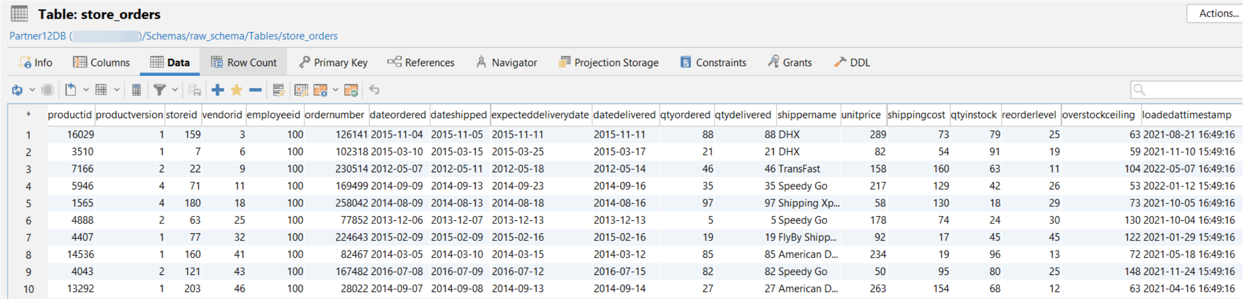


Table: store_orders

Partner12DB ([redacted])/Schemas/raw_schema/Tables/store_orders

*	productid	productversion	storeid	vendorid	employeeid	ordernumber	dateordered	dateshipped	expecteddeliverydate	datedelivered	qtyordered	qtydelivered	shippername	unitprice	shippingcost	qtyinstock	reorderlevel	overstockceiling	loadedattimestamp
1	16029	1	159	3	100	126141	2015-11-04	2015-11-05	2015-11-11	2015-11-11	88	88	DHX	289	73	79	25	63	2021-08-21 16:49:16
2	3510	1	7	6	100	102318	2015-03-10	2015-03-15	2015-03-25	2015-03-17	21	21	DHX	82	54	91	19	59	2021-11-10 15:49:16
3	7166	2	22	9	100	230514	2012-05-07	2012-05-11	2012-05-18	2012-05-14	46	46	TransFast	158	160	63	11	104	2022-05-07 16:49:16
4	5946	4	71	11	100	169499	2014-09-09	2014-09-13	2014-09-23	2014-09-16	35	35	Speedy Go	217	129	42	26	53	2022-01-12 15:49:16
5	1565	4	180	18	100	258042	2014-08-09	2014-08-13	2014-08-18	2014-08-16	97	97	Shipping Xp...	58	130	18	29	73	2021-10-05 16:49:16
6	4888	2	63	25	100	77852	2013-12-06	2013-12-07	2013-12-13	2013-12-13	5	5	Speedy Go	178	74	24	30	130	2021-10-04 16:49:16
7	4407	1	77	32	100	224643	2015-02-09	2015-02-09	2015-02-16	2015-02-16	19	19	FlyBy Shipp...	92	17	45	45	122	2021-01-29 15:49:16
8	14536	1	160	41	100	82467	2014-03-05	2014-03-10	2014-03-15	2014-03-12	85	85	American D...	234	19	96	13	72	2021-05-18 16:49:16
9	4043	2	121	43	100	167482	2016-07-08	2016-07-09	2016-07-12	2016-07-15	82	82	Speedy Go	50	95	80	25	148	2021-11-24 15:49:16
10	13292	1	203	46	100	28022	2014-09-07	2014-09-08	2014-09-13	2014-09-14	27	27	American D...	263	154	68	12	63	2021-04-16 16:49:16

Creating Models

A dbt model is a select statement that we write in a SQL file with the purpose of transforming data.

Staging Models

The following staging models standardize the column names in the raw tables and are in the **models > staging > vmart** directory.

> Note These models are built as views.

models > staging > vmart > stg_vendors.sql

This model creates the **dbt_schema.stg_vendors** view. It references the raw data table **vendors**.

```
with source as (
    select * from {{ source('raw_data', 'vendors') }}
),
staged as (
    select
        vendorid as vendor_key,
        vendorname as vendor_name,
        vendoraddress as vendor_address,
        vendorcity as vendor_city,
        vendorstate as vendor_state,
        lastdealupdate as last_deal_update,
        loadedattimestamp as loaded_at_timestamp
    from source
)

select * from staged
```

models > staging > vmart > stg_states.sql

This model creates the **dbt_schema.stg_states** view. It references the raw data table **states**.

```
with source as (
    select * from {{ source('raw_data', 'states') }}
),

staged as (
    select
        statename as state_name,
        statecode as state_code,
        region,
        division
    from source
)

select * from staged
```

models > staging > vmart > stg_store_orders.sql

This model creates the **dbt_schema.stg_store_orders** view. It references the raw data table **store_orders**.

```
with source as (
    select * from {{ source('raw_data', 'store_orders') }}
),
staged as (
    select
        productid as product_key,
        productversion as product_version,
        storeid as store_key,
        vendorid as vendor_key,
        employeeid as employee_key,
        ordernumber as order_number,
        dateordered as date_ordered,
        dateshipped as date_shipped,
        expecteddeliverydate as expected_delivery_date,
        datedelivered as date_delivered,
        qtyordered as quantity_ordered,
        qtydelivered as quantity_delivered,
        shippername as shipper_name,
        unitprice as unit_price,
        shippingcost as shipping_cost,
        qtyinstock as quantity_in_stock,
        reorderlevel as reorder_level,
        overstockceiling as overstock_ceiling,
        loadedattimestamp as loaded_at_timestamp
    from source
)

select * from staged
```

Marts Models

The following marts models apply business logic to transform the data in the staging models. They are in the **models > marts** directory.

> Note These models are built as tables.

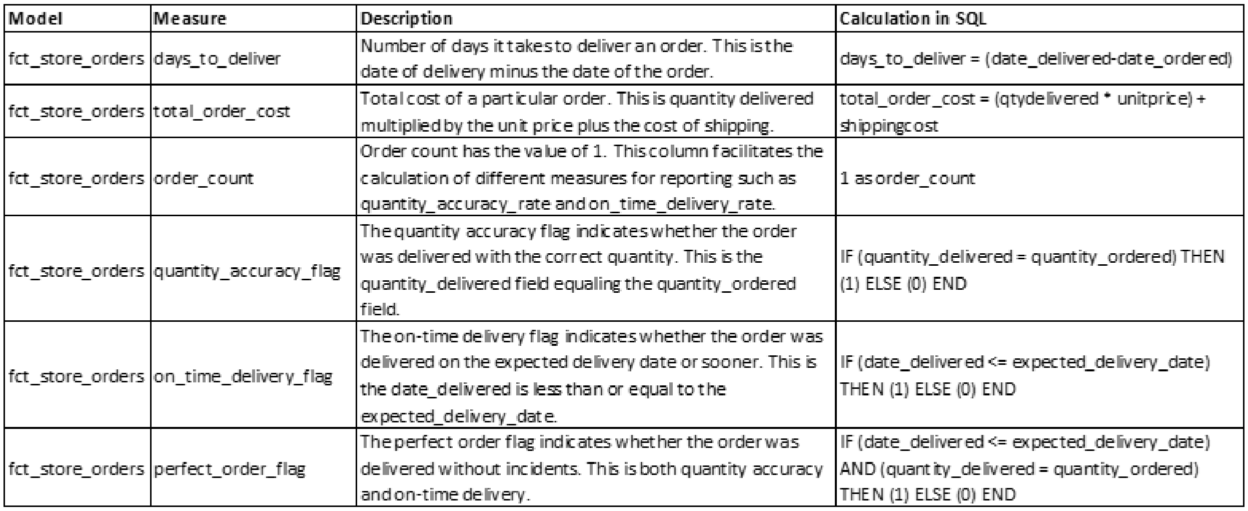
models > marts > dim_vendors.sql

This model creates the dimension table **dbt_schema.dim_vendors**. It references the staging tables **dbt_schema.stg_vendors** and **dbt_schema.stg_states** and brings the **vendor_region** column into the **dim_vendors** table by joining the staging tables.

```
{{ config (
    materialized = 'table'
    )
}}

with vendors as (
    select * from {{ ref('stg_vendors') }}
),

states as (
    select * from {{ ref('stg_states') }}
),

joined as (
    select
        vendor_key,
        vendor_name,
        vendor_address,
        vendor_city,
        vendor_state,
        states.region as vendor_region,
        last_deal_update,
        loaded_at_timestamp
    from
        vendors inner join states on
        vendors.vendor_state = states.state_code
),

final as (
    select * from joined
)

select * from final
```

models > marts > fct_store_orders.sql

This model creates the fact table **dbt_schema.fct_store_orders**. It references the staging table **dbt_schema.stg_store_orders** and applies business logic to calculate the metrics described below:



Model	Measure	Description	Calculation in SQL
fct_store_orders	days_to_deliver	Number of days it takes to deliver an order. This is the date of delivery minus the date of the order.	days_to_deliver = (date_delivered-date_ordered)
fct_store_orders	total_order_cost	Total cost of a particular order. This is quantity delivered multiplied by the unit price plus the cost of shipping.	total_order_cost = (qtydelivered * unitprice) + shippingcost
fct_store_orders	order_count	Order count has the value of 1. This column facilitates the calculation of different measures for reporting such as quantity_accuracy_rate and on_time_delivery_rate.	1 as order_count
fct_store_orders	quantity_accuracy_flag	The quantity accuracy flag indicates whether the order was delivered with the correct quantity. This is the quantity_delivered field equaling the quantity_ordered field.	IF (quantity_delivered = quantity_ordered) THEN (1) ELSE (0) END
fct_store_orders	on_time_delivery_flag	The on-time delivery flag indicates whether the order was delivered on the expected delivery date or sooner. This is the date_delivered is less than or equal to the expected_delivery_date.	IF (date_delivered <= expected_delivery_date) THEN (1) ELSE (0) END
fct_store_orders	perfect_order_flag	The perfect order flag indicates whether the order was delivered without incidents. This is both quantity accuracy and on-time delivery.	IF (date_delivered <= expected_delivery_date) AND (quantity_delivered = quantity_ordered) THEN (1) ELSE (0) END

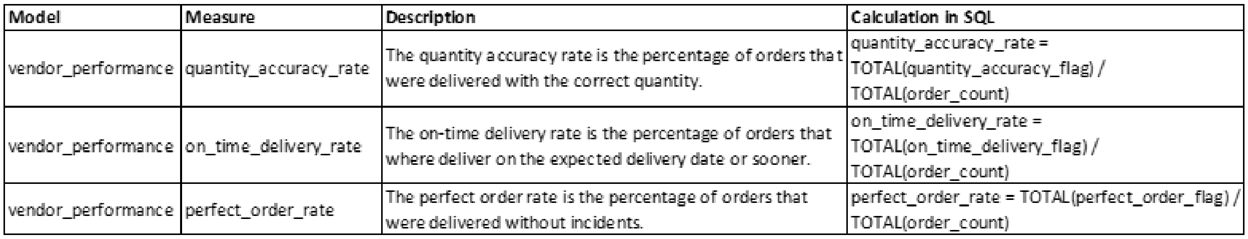
It also partitions the data by year on the **date_ordered** column. Vertica creates a partition key for each unique year of **date_ordered**.

> Note Partitioning large fact tables in your Vertica database is a good practice to improve query performance.

```
/*
    Create table fct_store_orders and partition data by order date year
    Vertica creates a partition key for each unique date_ordered year.
*/
{{ config(
    materialized = 'table',
    partition_by_string = 'YEAR(date_ordered)'
    )
}}

with store_orders as (
    select * from {{ ref('stg_store_orders') }}
),

fact as (
    select
        product_key,
        product_version,
        store_key,
        vendor_key,
        employee_key,
        order_number,
        date_ordered,
        date_shipped,
        expected_delivery_date,
        date_delivered,
        (date_delivered - date_ordered) as days_to_deliver,
        quantity_ordered,
        quantity_delivered,
        shipper_name,
        unit_price,
        shipping_cost,
        ((quantity_delivered * unit_price) + shipping_cost) as total_order_
cost,
        quantity_in_stock,
        reorder_level,
        overstock_ceiling,
        loaded_at_timestamp,
        1 as order_count,
        case when (quantity_delivered = quantity_ordered)
            then 1 else 0 end as quantity_accuracy_flag,
        case when (date_delivered <= expected_delivery_date)
            then 1 else 0 end as on_time_delivery_flag,
        case when (quantity_delivered = quantity_ordered) and
            (date_delivered <= expected_delivery_date)
            then 1 else 0 end as perfect_order_flag
    from
        store_orders
),

final as (
    select * from fact
)

select * from final
```

Report Models

The final model in the pipeline is called **vendor_performance** and is in the **models > reports** directory. This model creates the report table **dbt_schema.vendor_performance**. It references the fact table **dbt_schema.fct_store_orders** and dimension table **dbt_schema.dim_vendors** and applies business logic to calculate the metrics described below:



Model	Measure	Description	Calculation in SQL
vendor_performance	quantity_accuracy_rate	The quantity accuracy rate is the percentage of orders that were delivered with the correct quantity.	quantity_accuracy_rate = TOTAL(quantity_accuracy_flag) / TOTAL(order_count)
vendor_performance	on_time_delivery_rate	The on-time delivery rate is the percentage of orders that where deliver on the expected delivery date or sooner.	on_time_delivery_rate = TOTAL(on_time_delivery_flag) / TOTAL(order_count)
vendor_performance	perfect_order_rate	The perfect order rate is the percentage of orders that were delivered without incidents.	perfect_order_rate = TOTAL(perfect_order_flag) / TOTAL(order_count)

In addition, table and projection data is segmented by hash and sorted on the column **vendor_key**.

> Note This model is built as a table.

models > reports > vendor_performance.sql

```
/*
    Table and projection data are segmented by hash on the column vendor_key
    and sorted on the same column on which it is segmented.
    Data is evenly distributed across all cluster nodes.
*/
{{ config(
    materialized = 'table',
    order_by = 'vendor_key',
    segmented_by_string = 'vendor_key'
    )
}}

with vendors as (
    select * from {{ ref('dim_vendors') }}
),

store_orders as (
    select * from {{ ref('fct_store_orders') }}
),

joined as (
    select
        store_orders.vendor_key as "vendor_key",
        vendors.vendor_name as "Vendor Name",
        vendors.vendor_state as "Vendor State",
        vendors.vendor_region as "Vendor Region",
        avg(quantity_ordered) as "Avg Quatity Ordered",
        avg(quantity_delivered) as "Avg Quantity Delivered",
        avg(days_to_deliver) as "Avg Days to Deliver",
        avg(shipping_cost) as "Avg Shipping Cost",
        avg(total_order_cost) as "Avg Order Cost",
        sum(quantity_accuracy_flag) / count(order_count) as "Quantity
Accuracy Rate",
        sum(on_time_delivery_flag) / count(order_count) as "On-time Delivery
Rate",
        sum(perfect_order_flag) / count(order_count) as "Perfect Order Rate"
    from
        store_orders inner join vendors on
        vendors.vendor_key = store_orders.vendor_key
    group by
        1, 2, 3, 4
),

final as (
    select * from joined
)

select * from final
```

Converting to Incremental Models

The models we created in the previous section can be turned into incremental if needed. Incremental models only process new or updated data instead of rebuilding the whole table with each run. Incremental models perform better than table materializations specially when working with large tables.

We created two additional models in the **models > staging > vmart** directory, they are **stg_store_orders_merge.sql** and **stg_store_orders_insert_overwrite.sql**. These models incrementally update the **store_orders** information with new data that arrives in the raw table **store_orders**.

Converting to Incremental Using the Merge Strategy

This model uses the incremental strategy merge and creates the table **dbt_schema.stg_store_orders_merge**.

In this example:

- The destination table is **dbt_schema.stg_store_orders_merge** and the source table is **raw_schema.store_orders**.
- It uses the primary key **order_number** to match new or changed rows from the source table **store_orders** with rows in the destination table **stg_store_orders_merge**.

- It specifies the columns we care about updating with the **merge_update_columns** config parameter. These are the **date_delivered**, **quantity_delivered**, and **shipping_cost** columns.
- We want to update all rows that are new or changed since the last time we run the model; this condition is specified in the where clause.

models > staging > vmart > stg_store_orders_merge.sql

```
{{ config(
    materialized = 'incremental',
    incremental_strategy = 'merge',
    unique_key = 'order_number',
    merge_update_columns = ['date_delivered', 'quantity_delivered',
'shipping_cost']
    )
}}

with new_store_orders as (
    select * from {{ source('raw_data', 'store_orders') }}
    {% if is_incremental() %}
        where loadedattimestamp >= ( select max(loaded_at_timestamp) from
{{this}} )
    {% endif %}
),

updated_store_orders as (
    select
        productid as product_key,
        productversion as product_version,
        storeid as store_key,
        vendorid as vendor_key,
        employeeid as employee_key,
        ordernumber as order_number,
        dateordered as date_ordered,
        dateshipped as date_shipped,
        expecteddeliverydate as expected_delivery_date,
        datedelivered as date_delivered,
        qtyordered as quantity_ordered,
        qtydelivered as quantity_delivered,
        shippername as shipper_name,
        unitprice as unit_price,
        shippingcost as shipping_cost,
        qtyinstock as quantity_in_stock,
        reorderlevel as reorder_level,
        overstockceiling as overstock_ceiling,
        loadedattimestamp as loaded_at_timestamp
    from new_store_orders
)

select * from updated_store_orders
```

Under the Hood

These are the sequence of steps that dbt performs and executes in Vertica:

1. Compares the destination table with the source table and selects all rows whose column values changed or that are new since the last time we run the model. dbt creates a temp table with the rows that will be updated or inserted.
2. Executes a merge statement that uses the primary key **order_number** to update the rows if they exist or insert the rows if they are new.

```
MERGE
INTO
    "partner12db"."dbt_schema"."stg_store_orders_merge" AS DBT_INTERNAL_DEST
USING
    "stg_store_orders_merge__dbt_tmp" AS DBT_INTERNAL_SOURCE
ON
    DBT_INTERNAL_DEST."order_number" = DBT_INTERNAL_SOURCE."order_number"
WHEN MATCHED
    THEN
UPDATE
SET
    "date_delivered" = DBT_INTERNAL_SOURCE."date_delivered",
    "quantity_delivered" = DBT_INTERNAL_SOURCE."quantity_delivered",
    "shipping_cost" = DBT_INTERNAL_SOURCE."shipping_cost"
WHEN NOT MATCHED
    THEN
INSERT
    (
        "product_key",
        "product_version",
        "store_key",
        "vendor_key",
        "employee_key",
        "order_number",
        "date_ordered",
        "date_shipped",
        "expected_delivery_date",
        "date_delivered",
        "quantity_ordered",
        "quantity_delivered",
        "shipper_name",
        "unit_price",
        "shipping_cost",
        "quantity_in_stock",
        "reorder_level",
        "overstock_ceiling",
        "loaded_at_timestamp"
    )
    VALUES
    (
        DBT_INTERNAL_SOURCE."product_key",
        DBT_INTERNAL_SOURCE."product_version",
        DBT_INTERNAL_SOURCE."store_key",
        DBT_INTERNAL_SOURCE."vendor_key",
        DBT_INTERNAL_SOURCE."employee_key",
        DBT_INTERNAL_SOURCE."order_number",
        DBT_INTERNAL_SOURCE."date_ordered",
        DBT_INTERNAL_SOURCE."date_shipped",
        DBT_INTERNAL_SOURCE."expected_delivery_date",
        DBT_INTERNAL_SOURCE."date_delivered",
        DBT_INTERNAL_SOURCE."quantity_ordered",
        DBT_INTERNAL_SOURCE."quantity_delivered",
        DBT_INTERNAL_SOURCE."shipper_name",
        DBT_INTERNAL_SOURCE."unit_price",
        DBT_INTERNAL_SOURCE."shipping_cost",
        DBT_INTERNAL_SOURCE."quantity_in_stock",
        DBT_INTERNAL_SOURCE."reorder_level",
        DBT_INTERNAL_SOURCE."overstock_ceiling",
        DBT_INTERNAL_SOURCE."loaded_at_timestamp"
    )
```

Converting to Incremental Using the insert_overwrite Strategy

This model uses the incremental strategy **insert_overwrite** and creates the **dbt_schema.stg_store_orders_insert_overwrite** table.

The **insert_overwrite** strategy deletes and inserts rows in the destination table based on partitions. The **partition_by_string** config parameter, is an expression to divide the destination table in partitions. The **partitions** config parameter, specify the partitions that will be dropped in the destination and inserted from source.

In this example:

- The destination table is **dbt_schema.stg_store_orders_insert_overwrite** and the source table is **raw_schema.store_orders**.
- The destination table is divided into yearly partitions on the **date_ordered** column.
- The partitions specified in the **partitions** config parameter are the same partitions specified in the where clause.
- Assuming the current year is 2023, we want to replace the 2023 and 2022 partitions.

> Important The **partitions** config parameter is optional. If the **partitions** config parameter is specified in addition to the where clause the following two scenarios can occur:
>
> - The destination table might end up missing partitions from source. This is the case if some partitions specified in the **partitions** config parameter are not specified in the where clause. All partitions in the **partitions** config parameter will be dropped from the destination table but not all partitions will be inserted back from source.
> - The destination table might end up with duplicate rows. This is the case if not all partitions specified in the where clause are specified in the **partitions** config parameter. All partitions in the config parameter will be dropped from the destination but additional partitions from source specified in the where clause will be inserted in the destination table.

models > staging > vmart > stg_store_orders_insert_overwrite.sql

```
{{ config(
    materialized = 'incremental',
    incremental_strategy = 'insert_overwrite',
    partition_by_string = 'year(date_ordered)',
    partitions = ['2022', '2023']
    )
}}

with new_store_orders as (
    select * from {{ source('raw_data', 'store_orders') }}
    {% if is_incremental() %}
        where YEAR(dateordered) >= YEAR(now())-1
    {% endif %}
),
updated_store_orders as (
    select
        productid as product_key,
        productversion as product_version,
        storeid as store_key,
        vendorid as vendor_key,
        employeeid as employee_key,
        ordernumber as order_number,
        dateordered as date_ordered,
        dateshipped as date_shipped,
        expecteddeliverydate as expected_delivery_date,
        datedelivered as date_delivered,
        qtyordered as quantity_ordered,
        qtydelivered as quantity_delivered,
        shippername as shipper_name,
        unitprice as unit_price,
        shippingcost as shipping_cost,
        qtyinstock as quantity_in_stock,
        reorderlevel as reorder_level,
        overstockceiling as overstock_ceiling,
        loadedattimestamp as loaded_at_timestamp
    from new_store_orders
)

select * from updated_store_orders
```

Under the Hood

The first time the model runs, the table is partitioned by the expression specified in the config parameter **partition_by_string**. In this example the destination table **dbt_schema.stg_store_orders_insert_overwrite** is created with data from the source table **raw_schema.store_orders** and partitioned by year based on the **date_ordered** column.

This is the DDL executed the first time the model runs:

```
create  table
    "partner12db"."dbt_schema"."stg_store_orders_insert_overwrite"
INCLUDE SCHEMA PRIVILEGES as (
with new_store_orders as (
        select * from "partner12db"."raw_schema"."store_orders"
),
updated_store_orders as (
    select
        productid as product_key,
        productversion as product_version,
        storeid as store_key,
        vendorid as vendor_key,
        employeeid as employee_key,
        ordernumber as order_number,
        dateordered as date_ordered,
        dateshipped as date_shipped,
        expecteddeliverydate as expected_delivery_date,
        datedelivered as date_delivered,
        qtyordered as quantity_ordered,
        qtydelivered as quantity_delivered,
        shippername as shipper_name,
        unitprice as unit_price,
        shippingcost as shipping_cost,
        qtyinstock as quantity_in_stock,
        reorderlevel as reorder_level,
        overstockceiling as overstock_ceiling,
    from new_store_orders)

select * from updated_store_orders
);
alter table "partner12db"."dbt_schema"."stg_store_orders_insert_overwrite"
partition by year(date_ordered);
```

In subsequent runs:

1. dbt uses a drop partitions statement to delete all rows in the destination table for each partition specified in the where clause. In this example, the partitions correspond to all years of **ordered_date** that are greater or equal to current year – 1. This means if current year is 2023 then the partitions to drop are 2023 and 2022.
2. dbt uses an insert statement to insert the selected rows from source to destination. The selected rows from source, are the rows that correspond to the partitions specified in the where clause. In this example the rows inserted in the destination table are the rows for years 2023 and 2022.

These are the DDL and DML executed for subsequent runs:

```
select PARTITION_TABLE('dbt_schema.stg_store_orders_insert_overwrite');
```

```
SELECT DROP_PARTITIONS('dbt_schema.stg_store_orders_insert_overwrite',
'2022', '2022');
SELECT PURGE_PARTITION('dbt_schema.stg_store_orders_insert_overwrite',
'2022');

SELECT DROP_PARTITIONS('dbt_schema.stg_store_orders_insert_overwrite',
'2023', '2023');
SELECT PURGE_PARTITION('dbt_schema.stg_store_orders_insert_overwrite',
'2023');

insert into "partner12db"."dbt_schema"."stg_store_orders_insert_overwrite"
("product_key", "product_version", "store_key",
"vendor_key", "employee_key", "order_number",
"date_ordered", "date_shipped", "expected_delivery_date",
"date_delivered", "quantity_ordered", "quantity_delivered",
"shipper_name", "unit_price", "shipping_cost", "quantity_in_stock",
"reorder_level", "overstock_ceiling", "loaded_at_timestamp")
(
select "product_key", "product_version", "store_key",
"vendor_key", "employee_key", "order_number", "date_ordered",
"date_shipped", "expected_delivery_date", "date_delivered",
"quantity_ordered", "quantity_delivered", "shipper_name",
"unit_price", "shipping_cost", "quantity_in_stock",
"reorder_level", "overstock_ceiling", "loaded_at_timestamp"
from "stg_store_orders_insert_overwrite__dbt_tmp"
);
```

Documentation and Tests for Models

The documentation and test for models are specified in the following .yml files:

models > staging > vmart > stg_vmart.yml

This file describes the staging models and tests the primary keys.

```
version: 2

models:
  - name: stg_states
    description: This is the staged states table.
    columns:
      - name: state_code
        description: The primary key of the stg_states table.
        tests:
          - not_null
          - unique

  - name: stg_vendors
    description: This is the staged vendors table.
    columns:
      - name: vendor_key
        description: The primary key of the stg_vendors table.
        tests:
          - not_null
          - unique

  - name: stg_store_orders
    description: This is the staged store_orders table.
    columns:
      - name: order_number
        description: The primary key of the stg_store_orders table.
        tests:
          - not_null
          - unique
```

models > marts > marts.yml

This file describes the metrics in the marts models and tests the primary keys.

```
version: 2

models:
  - name: dim_vendors
    description: "This is the vendors dimension table."
    columns:
      - name: vendor_key
        description: The primary key of the vendors dimension table.
        tests:
          - not_null
          - unique

  - name: fct_store_orders
    description: "This is the store orders fact table."
    columns:
      - name: order_number
```

```
        description: The primary key of the store orders fact table.
        tests:
          - not_null
          - unique

      - name: days_to_deliver
        description: "Number of days it takes to deliver an order. This is
the date of delivery \n
          minus the date of the order. Example: days_to_deliver = (date_
delivered-date_ordered)"

      - name: total_order_cost
        description: "Total cost of a particular order. This is quantity
delivered multiplied by \n
          the unit price plus the cost of shipping. Example: total_order_
cost = \n
          (qtydelivered * unitprice) + shippingcost"

      - name: order_count
        description: "Order count has the value of 1. This column
facilitates the calculation of \n
          different measures for reporting such as quantity_accuracy_rate
and on_time_delivery_rate."

      - name: quantity_accuracy_flag
        description: "The quantity accuracy flag indicates whether the order
was delivered \n
          with the correct quantity. \n
          This is the quantity_delivered field equaling the quantity_ordered
field. \n
          An example of this calculation is: \n
          IF (quantity_delivered = quantity_ordered) THEN (1) ELSE (0) END."

      - name: on_time_delivery_flag
        description: "The on-time delivery flag indicates whether the order
was delivered \n
          on the expected delivery date or sooner. \n
          This is the date_delivered is less than or equal to the expected_
delivery_date. \n
          An example of this calculation is: \n
          IF (date_delivered <= expected_delivery_date) THEN (1) ELSE (0)
```

```
END."

      - name: perfect_order_flag
        description: "The perfect order flag indicates whether the order was 
delivered without \n
          incidents. \n
          This is both quantity accuracy and on-time delivery. \n
          An example of this calculation is: \n
          IF (date_delivered <= expected_delivery_date) AND \n
          (quantity_delivered = quantity_ordered) THEN (1) ELSE (0) END."
```

models > reports > reports.yml

This file describes the metrics in the reports model and tests the primary key.

```
version: 2

models:
  - name: vendor_performance
    description: "This table is used by end-users for visualization purposes 
\n
      and contains information about vendor performance KPIs."

    columns:
      - name: vendor_key
        description: The primary key of the vendor_performance table.
        tests:
          - not_null
          - unique

      - name: quantity_accuracy_rate
        description: "The quantity accuracy rate is the percentage of orders 
that were delivered \n
          with the correct quantity. \n
          quantity_accuracy_rate = TOTAL(quantity_accuracy_flag) / TOTAL
(order_count)"

      - name: on_time_delivery_rate
        description: "The on-time delivery rate is the percentage of orders 
that where deliver \n
          on the expected delivery date or sooner. \n
          on_time_delivery_rate = TOTAL(on_time_delivery_flag) / TOTAL
```

```
(order_count)"

      - name: perfect_order_rate
        description: "The perfect order rate is the percentage of orders 
that were delivered \n
          without incidents. \n
          perfect_order_rate = TOTAL(perfect_order_flag) / TOTAL(order_
count)"
```

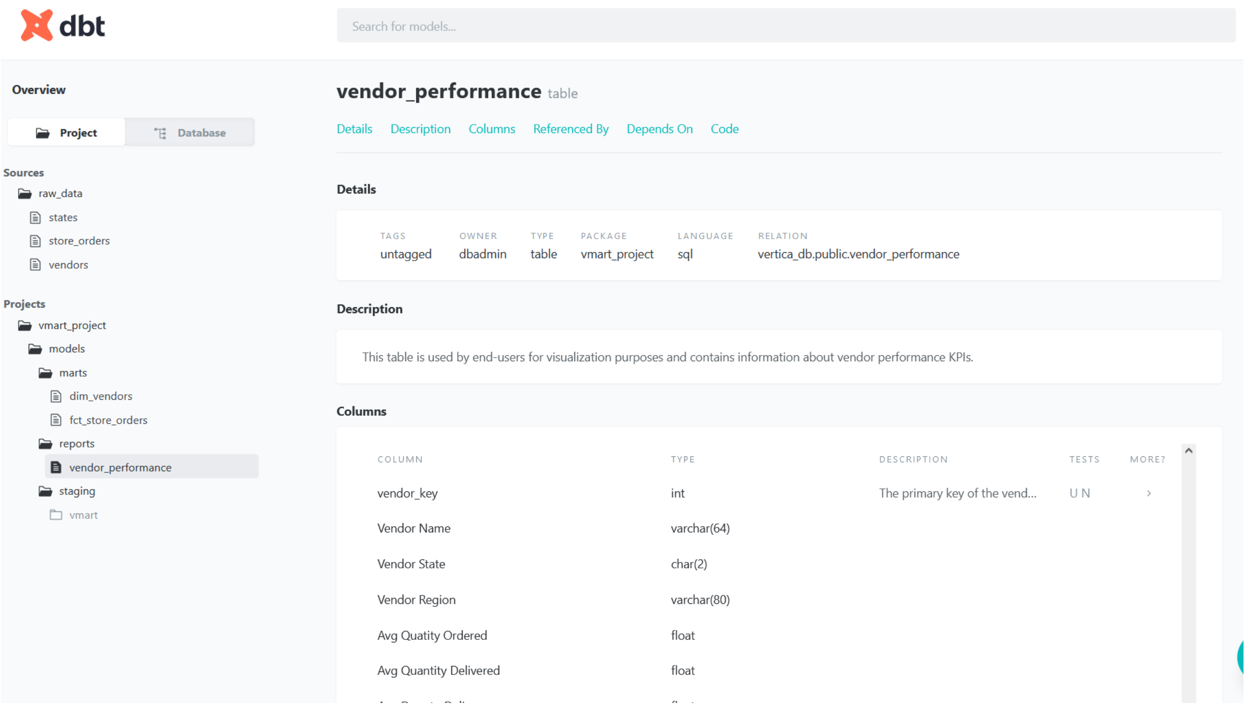
Running and Testing the Solution

To build the solution, execute the **dbt build** command. This command runs and tests all models upstream including the last model. It also runs the tests on the sources specified in **src_vmart.yml**.

Generating Documentation and Lineage Graph

To generate the lineage graph and examine the dependencies of the project's pipeline, execute:

dbt docs generate and **dbt docs serve**. In the documentation website click on the DAG icon:



vendor_performance table

Details

TAGS	OWNER	TYPE	PACKAGE	LANGUAGE	RELATION
untagged	dbadmin	table	vmart_project	sql	vertica_db.public.vendor_performance

Description

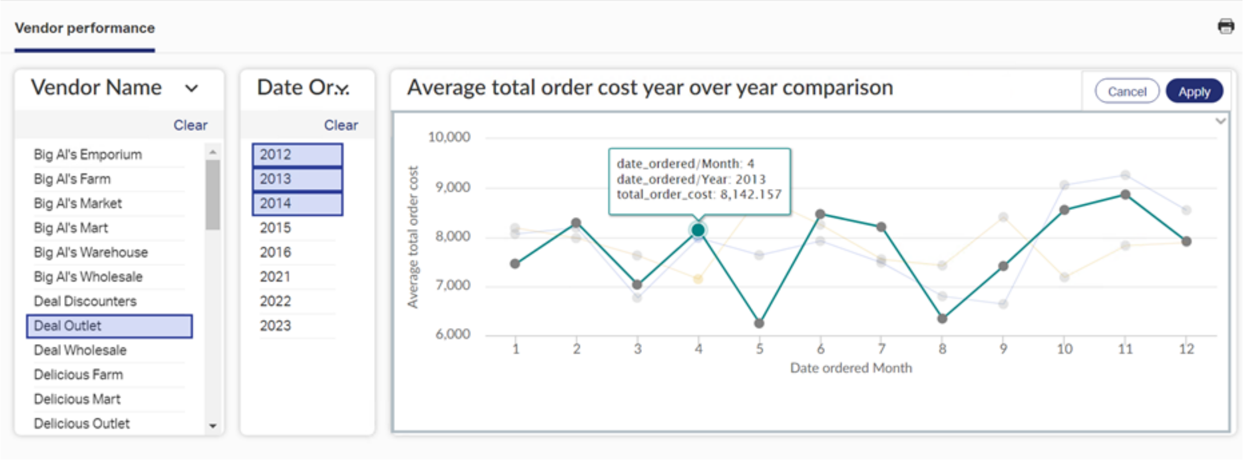
This table is used by end-users for visualization purposes and contains information about vendor performance KPIs.

Columns

COLUMN	TYPE	DESCRIPTION	TESTS	MORE?
vendor_key	int	The primary key of the vend...	U N	›
Vendor Name	varchar(64)			
Vendor State	char(2)			
Vendor Region	varchar(80)			
Avg Quatity Ordered	float			
Avg Quantity Delivered	float			

Visualizing the Transformed Data

You can use any tool of your preference to connect to Vertica and visualize the data of the tables generated by dbt. In this example, we used Magellan by OpenText to create a dashboard of Vendor performance:



Summary and Conclusions

We created a comprehensive example of a data transformation pipeline that uses business logic to transform raw data into a dimension and fact table for business analytics and reporting.

Vertica + dbt constitute a powerful solution for in-database data transformation that leverages the speed of your database.

For More Information

- dbt documentation
- dbt Community
- dbt-vertica (PyPI | Github)
- dbt-vertica setup page
- dbt-vertica configuration page
- Vertica Community Edition
- Vertica Documentation
- Vertica User Community