Data Engineering Zoomcamp

Analytics Engineering

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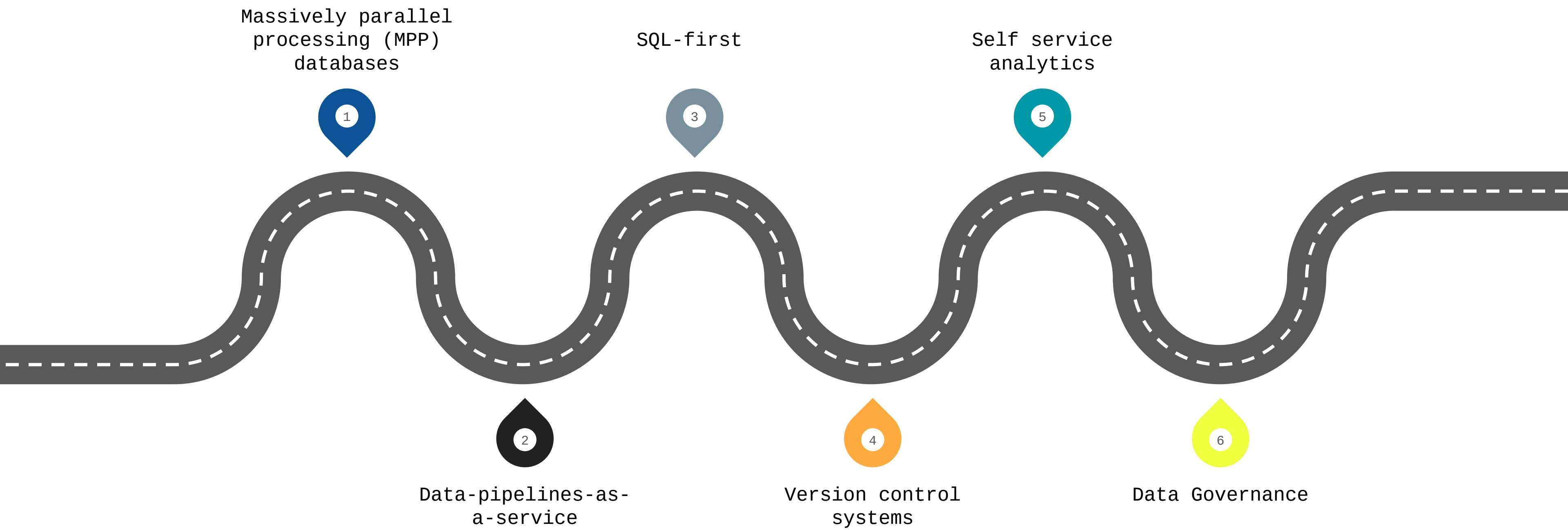
What is Analytics Engineering?

DATA DOMAIN DEVELOPMENTS



1 Massively parallel processing (MPP) databases

2 Data-pipelines-as-a-service

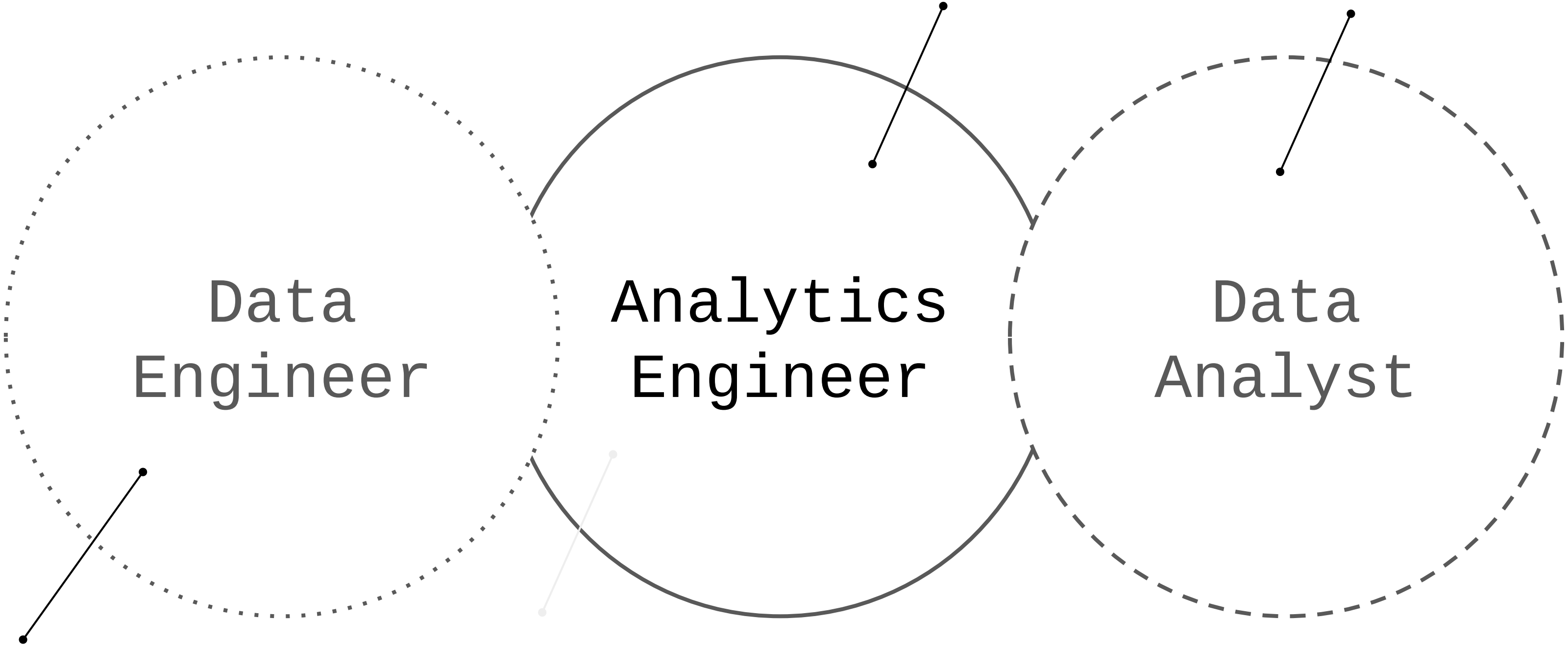
3 SQL-first

4 Version control systems

5 Self service analytics

6 Data Governance

ROLES IN A DATA TEAM

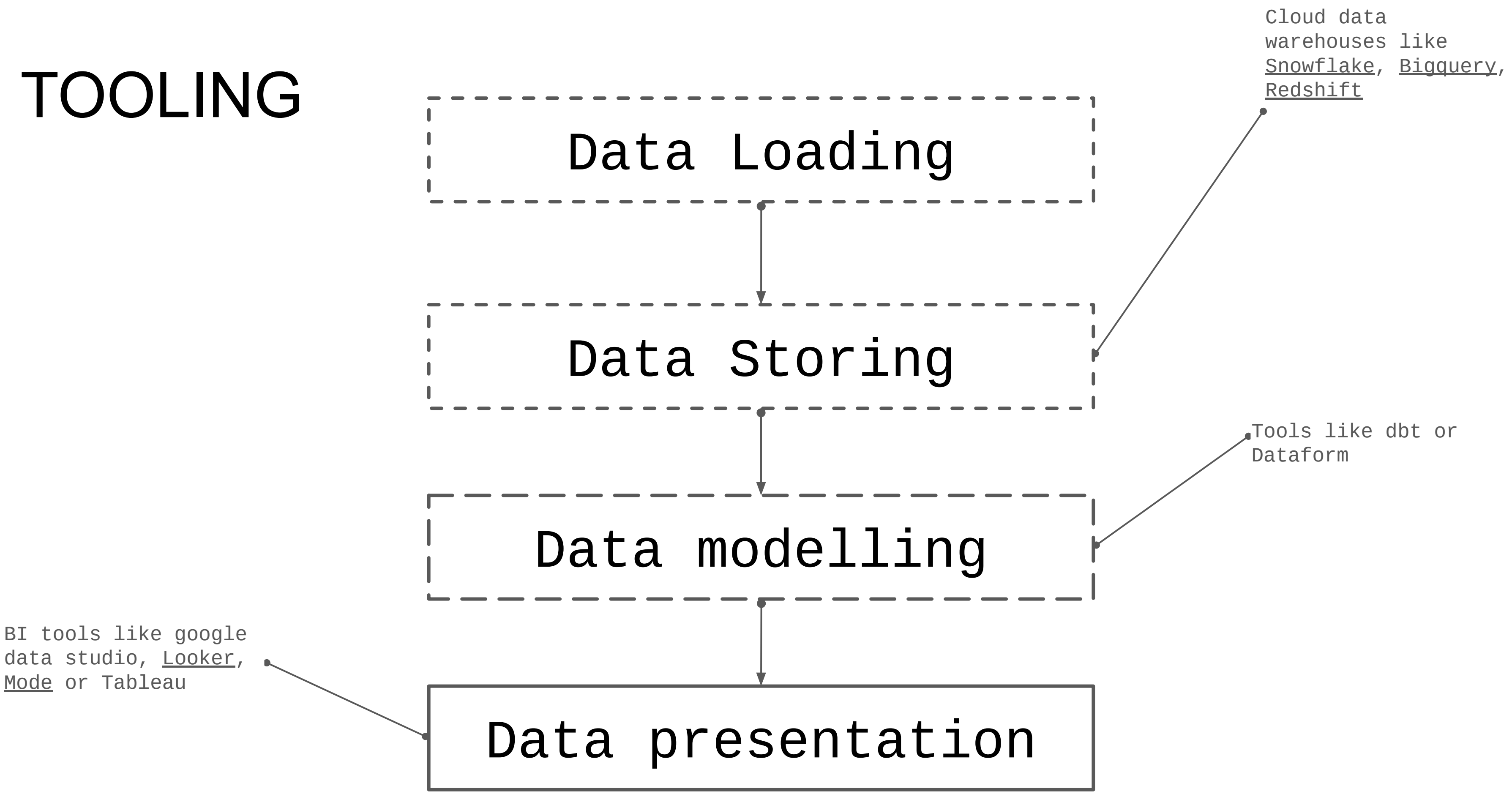


Introduces the good software engineering practices to the efforts of data analysts and data scientists

Uses data to answer questions and solve problems.

Prepares and maintain the infrastructure the data team needs.

TOOLING



Data Loading

Data Storing

Data modelling

Data presentation

Cloud data warehouses like Snowflake, Bigquery, Redshift

Tools like dbt or Dataform

BI tools like google data studio, Looker, Mode or Tableau

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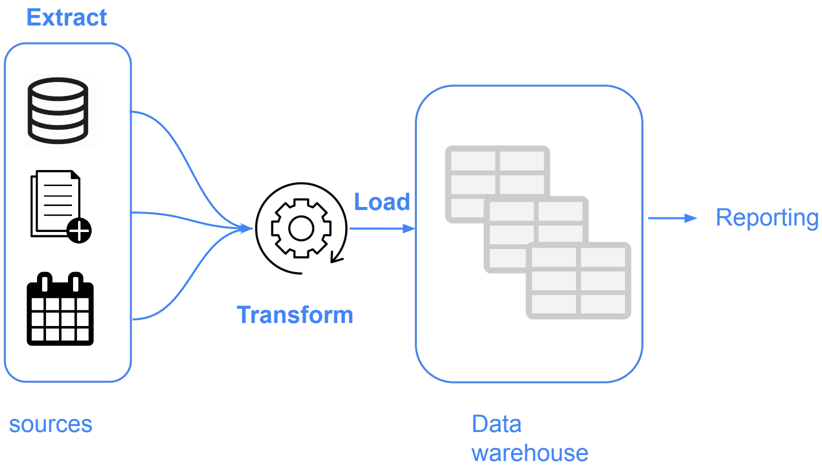
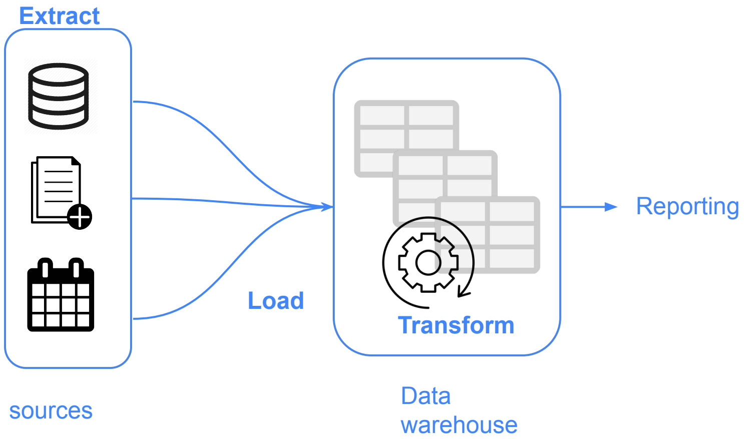
Data Modelling concepts

ETL vs ELT





- Slightly more stable and compliant data analysis
- Higher storage and compute costs

- Faster and more flexible data analysis.
- Lower cost and lower maintenance

Kimball’s Dimensional Modeling

Objective

- Deliver data understandable to the business users
- Deliver fast query performance

Approach

Prioritise user understandability and query performance over non redundant data (3NF)

Other approaches

- Bill Inmon
- Data vault

Elements of Dimensional Modeling

Facts tables

- Measurements, metrics or facts
- Corresponds to a business *process*
- “verbs”

Dimensions tables

- Corresponds to a business *entity*
- Provides context to a business process
- “nouns”

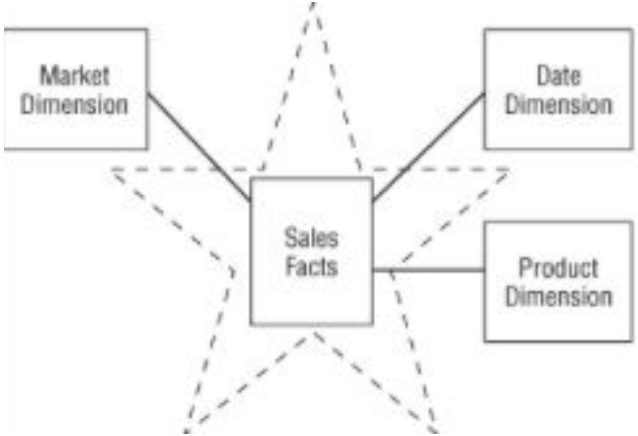


Image: The data warehouse toolkit

Architecture of Dimensional Modeling

Stage Area

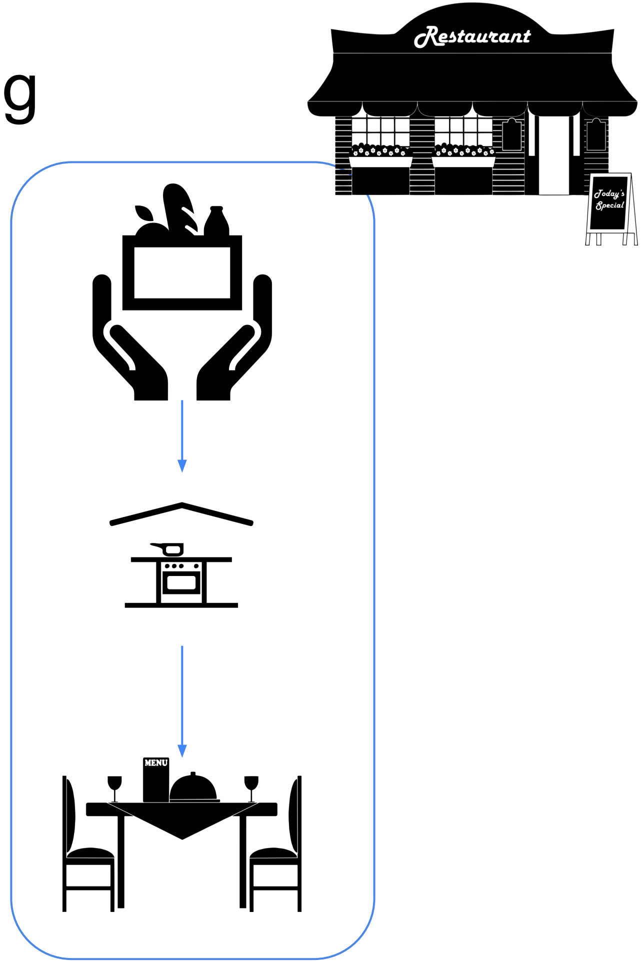
- Contains the raw data
- Not meant to be exposed to everyone

Processing area

- From raw data to data models
- Focuses in efficiency
- Ensuring standards

Presentation area

- Final presentation of the data
- Exposure to business stakeholder



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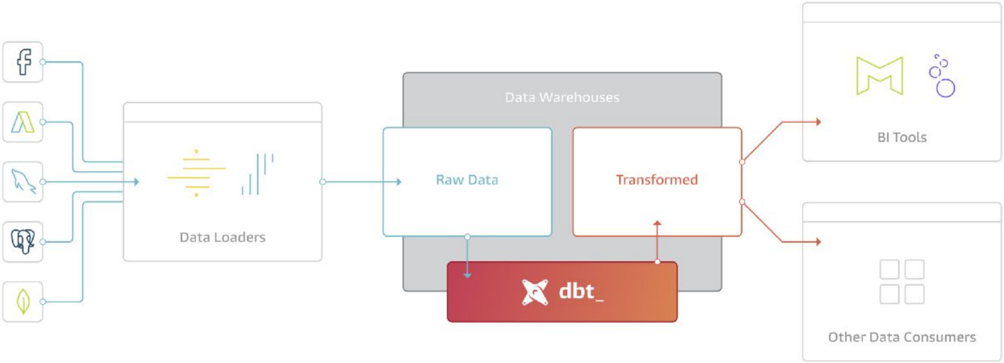
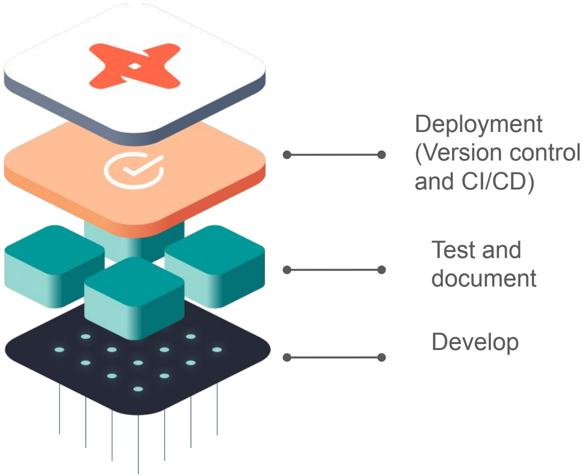
What is dbt?

What is dbt?

dbt is a transformation workflow that allows anyone that knows SQL to deploy analytics code following software engineering best practices like modularity, portability, CI/CD, and documentation.





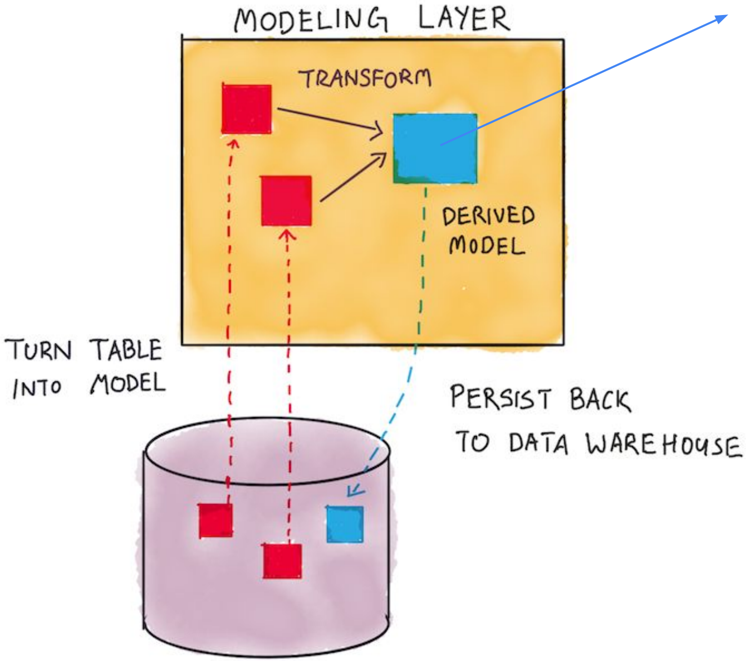
Deployment (Version control and CI/CD)

Test and document

Develop

Image: getdbt.com

How does dbt work?



Each model is:

- A *.sql file
- Select statement, no DDL or DML
- A file that dbt will compile and run in our DWH

Image: holistics.io and getdbt.com

How to use dbt?

dbt Core

Open-source project that allows the data transformation

- Builds and runs a dbt project (.sql and .yml files)
- Includes SQL compilation logic, macros and database adapters
- Includes a CLI interface to run dbt commands locally
- Opens source and free to use

dbt Cloud

SaaS application to develop and manage dbt projects.

- Web-based IDE and cloud CLI to develop, run and test a dbt project
- Managed environments
- Jobs orchestration
- Logging and Alerting
- Integrated documentation
- Admin and metadata API
- Semantic Layer

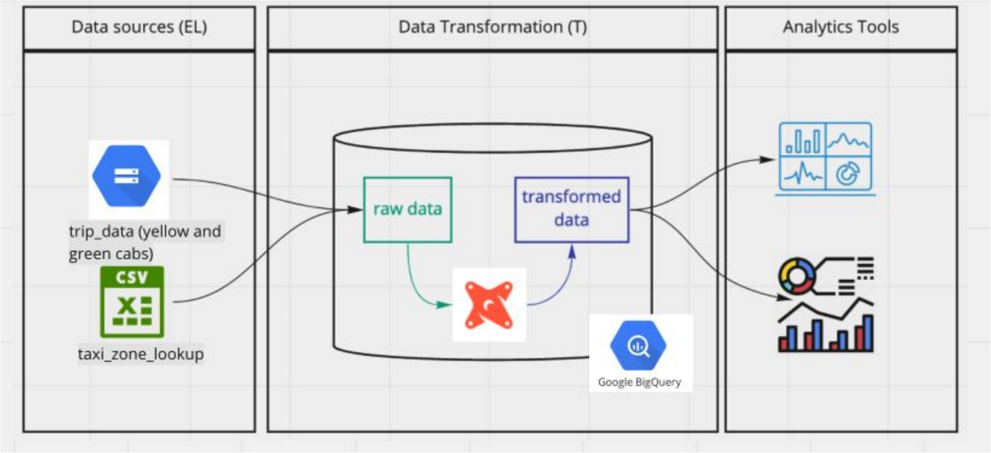
How are we going to use dbt?

BigQuery

- Development using cloud IDE
- No local installation of dbt core

Postgres

- Development using a local IDE of your choice.
- Local installation of dbt core connecting to the Postgres database
- Running dbt models through the CLI



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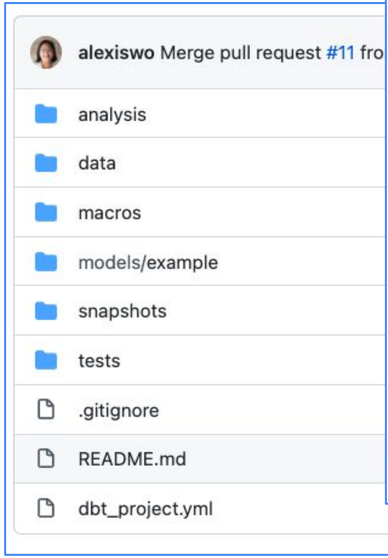
Starting a dbt project

Create a new dbt project

dbt provides an starter project with all the basic folders and files.
There are essentially two ways to use it:

With the CLI
After having installed dbt locally and setup the *profiles.yml*, run `dbt init` in the path we want to start the project to clone the starter project.

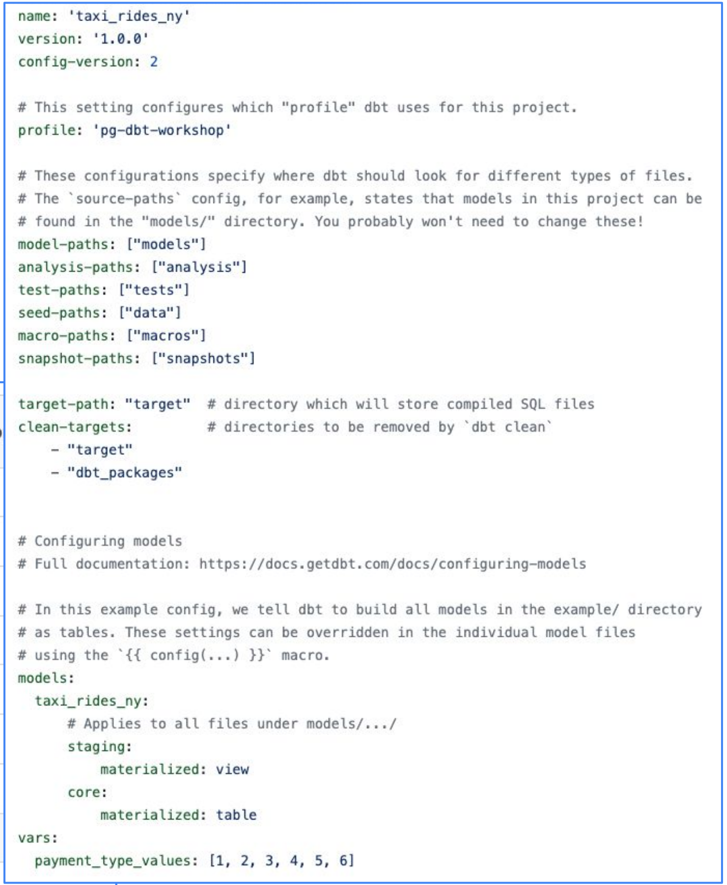
With dbt cloud
After having set up the dbt cloud credentials (repo and dwh) we can start the project from the web-based IDE



alexiswo Merge pull request #11 fro

- analysis
- data
- macros
- models/example
- snapshots
- tests
- .gitignore
- README.md
- dbt_project.yml

Starter project structure



```yaml
name: 'taxi_rides_ny'
version: '1.0.0'
config-version: 2

# This setting configures which "profile" dbt uses for this project.
profile: 'pg-dbt-workshop'

# These configurations specify where dbt should look for different types of files.
# The `source-paths` config, for example, states that models in this project can be
# found in the "models/" directory. You probably won't need to change these!
model-paths: ["models"]
analysis-paths: ["analysis"]
test-paths: ["tests"]
seed-paths: ["data"]
macro-paths: ["macros"]
snapshot-paths: ["snapshots"]

target-path: "target"  # directory which will store compiled SQL files
clean-targets:         # directories to be removed by `dbt clean`
    - "target"
    - "dbt_packages"


# Configuring models
# Full documentation: https://docs.getdbt.com/docs/configuring-models

# In this example config, we tell dbt to build all models in the example/ directory
# as tables. These settings can be overridden in the individual model files
# using the `{{ config(...) }}` macro.
models:
  taxi_rides_ny:
      # Applies to all files under models/.../
      staging:
          materialized: view
      core:
          materialized: table
vars:
  payment_type_values: [1, 2, 3, 4, 5, 6]
```

dbt_proyect.yml

Extra documentation link

5

Development of dbt models

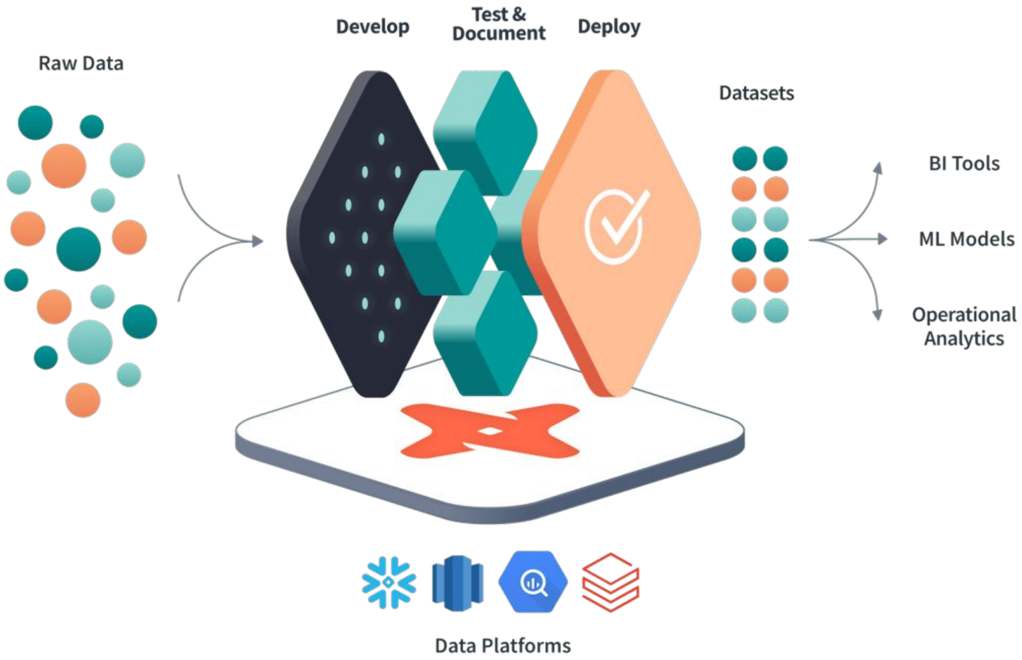
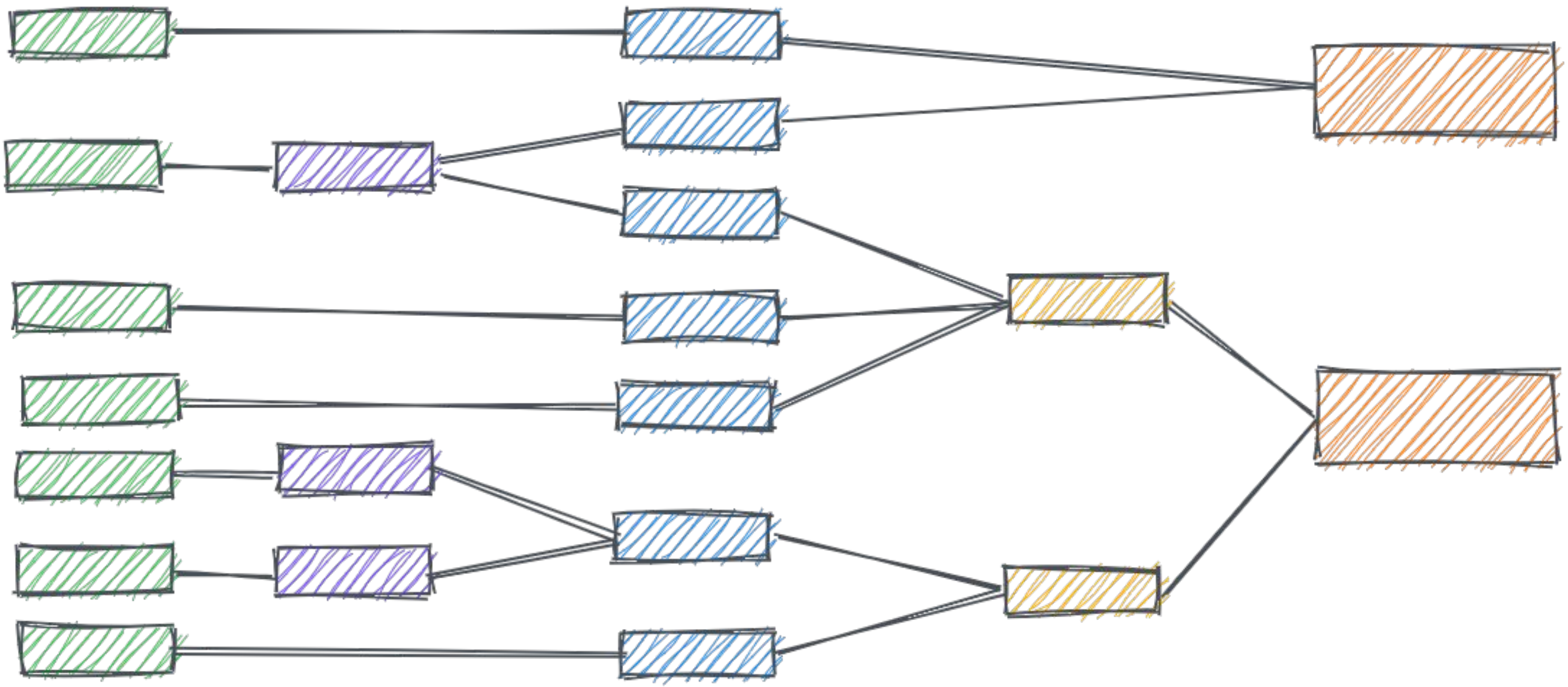


Image: getdbt.com

Modular data modeling



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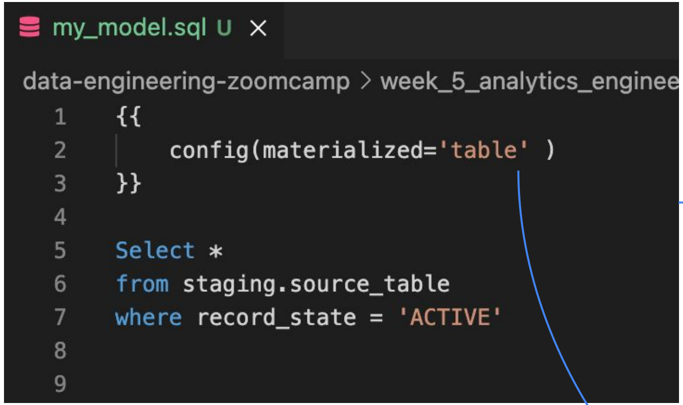
Anatomy of a dbt model

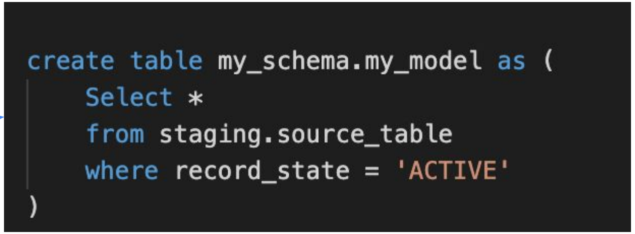
dbt model



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

Select *
from staging.source_table
where record_state = 'ACTIVE'
```

Compiled code



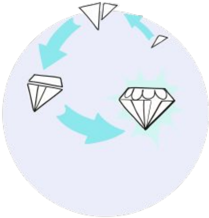
```
create table my_schema.my_model as (
    Select *
    from staging.source_table
    where record_state = 'ACTIVE'
)
```

Runs compiled code in the data warehouse

Several materialization strategies

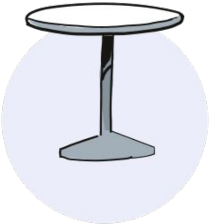
- Table
- View
- Incremental
- Ephemeral

Materializations in dbt Cloud



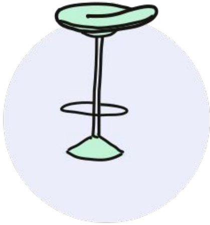
Ephemeral

Ephemeral materializations are temporary and exist only for the duration of a single dbt run.



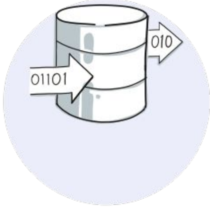
View

Views are virtual tables created by dbt that can be queried like regular tables.



Table

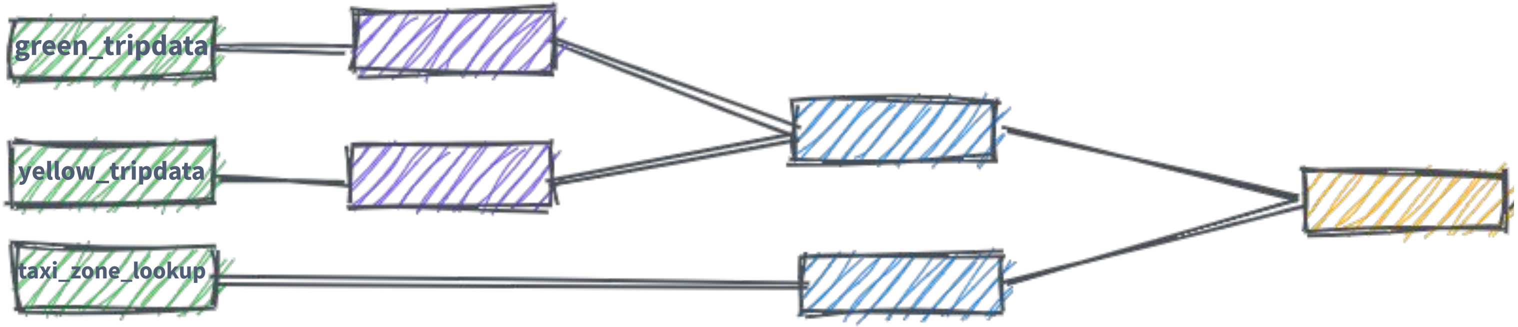
Tables are physical representations of data that are created and stored in the database.



Incremental

Incremental materializations are a powerful feature of dbt that allow for efficient updates to existing tables, reducing the need for full data refreshes.

Modular data modeling

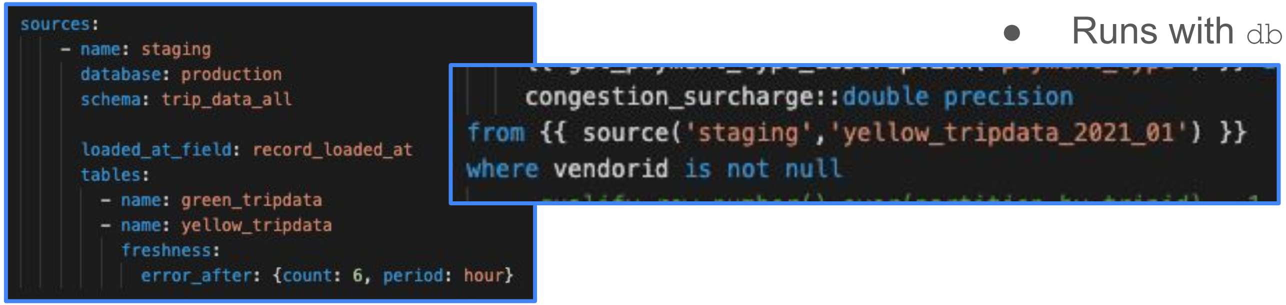


Img source

The FROM clause of a dbt model

Sources

- The data loaded to our dwh that we use as sources for our models
- Configuration defined in the yml files in the models folder
- Used with the source macro that will resolve the name to the right schema, plus build the dependencies automatically
- Source freshness can be defined and tested

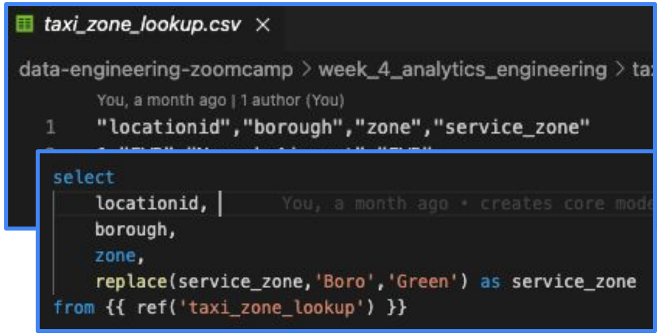


```yaml
sources:
    - name: staging
      database: production
      schema: trip_data_all

      loaded_at_field: record_loaded_at
      tables:
        - name: green_tripdata
        - name: yellow_tripdata
          freshness:
            error_after: {count: 6, period: hour}
```

```sql
        congestion_surcharge::double precision
from {{ source('staging','yellow_tripdata_2021_01') }}
where vendorid is not null
```

Seeds


taxi_zone_lookup.csv
data-engineering-zoomcamp > week_4_analytics_engineering > ta
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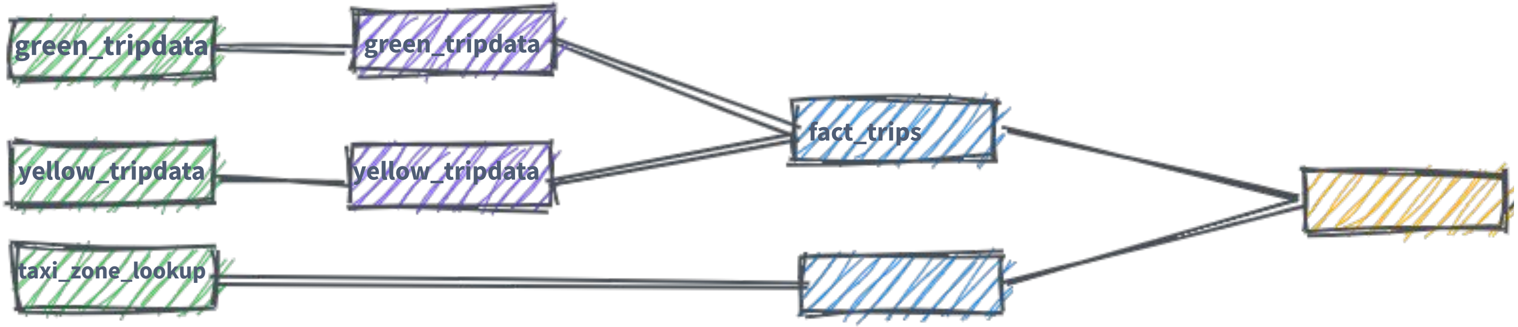
You, a month ago • creates core mode

```
"locationid","borough","zone","service_zone"
```

```sql
select
    locationid,
    borough,
    zone,
    replace(service_zone,'Boro','Green') as service_zone
from {{ ref('taxi_zone_lookup') }}
```

- CSV files stored in our repository under the seed folder
- Benefits of version controlling
- Equivalent to a copy command
- Recommended for data that doesn’t change frequently
- Runs with `dbt seed -s file_name`

Modular data modeling



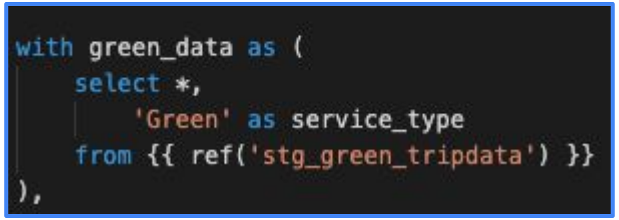
Img source

The FROM clause of a dbt model

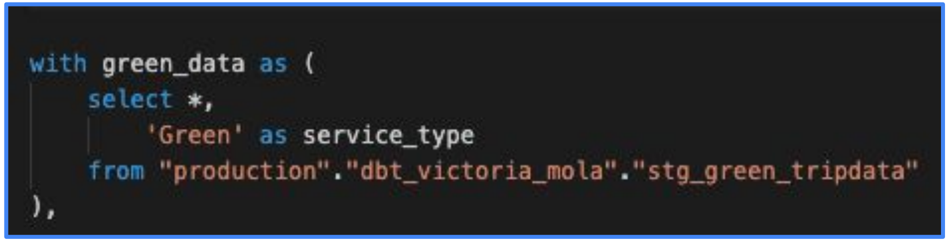
Ref

- Macro to reference the underlying tables and views that were building the data warehouse
- Run the same code in any environment, it will resolve the correct schema for you
- Dependencies are built automatically

dbt model



```
with green_data as (
    select *,
        'Green' as service_type
    from {{ ref('stg_green_tripdata') }}
),
```

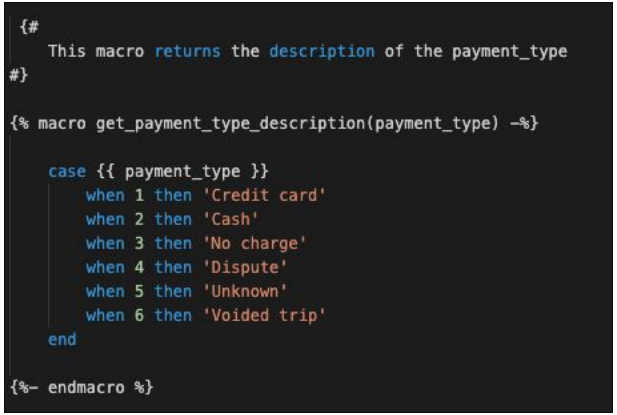


```
with green_data as (
    select *,
        'Green' as service_type
    from "production"."dbt_victoria_mola"."stg_green_tripdata"
),
```

Compiled code

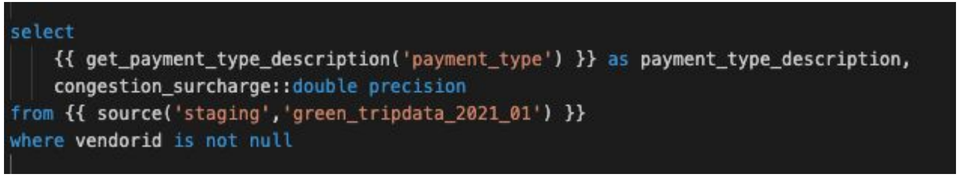
Macros

- Use control structures (e.g. if statements and for loops) in SQL
- Use environment variables in your dbt project for production deployments
- Operate on the results of one query to generate another query
- Abstract snippets of SQL into reusable macros — these are analogous to functions in most programming languages.



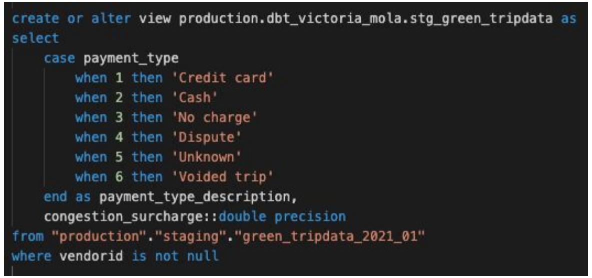
```
 {#
    This macro returns the description of the payment_type
#}

{% macro get_payment_type_description(payment_type) -%}

    case {{ payment_type }}
        when 1 then 'Credit card'
        when 2 then 'Cash'
        when 3 then 'No charge'
        when 4 then 'Dispute'
        when 5 then 'Unknown'
        when 6 then 'Voided trip'
    end

{%- endmacro %}
```

Definition of the macro



```
select
    {{ get_payment_type_description('payment_type') }} as payment_type_description,
    congestion_surcharge::double precision
from {{ source('staging','green_tripdata_2021_01') }}
where vendorid is not null
```

Usage of the macro

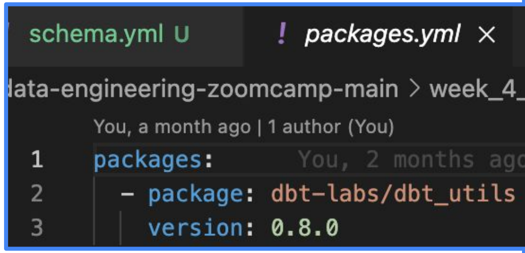


```
create or alter view production.dbt_victoria_mola.stg_green_tripdata as
select
    case payment_type
        when 1 then 'Credit card'
        when 2 then 'Cash'
        when 3 then 'No charge'
        when 4 then 'Dispute'
        when 5 then 'Unknown'
        when 6 then 'Voided trip'
    end as payment_type_description,
    congestion_surcharge::double precision
from "production"."staging"."green_tripdata_2021_01"
where vendorid is not null
```

Compiled code of the macro

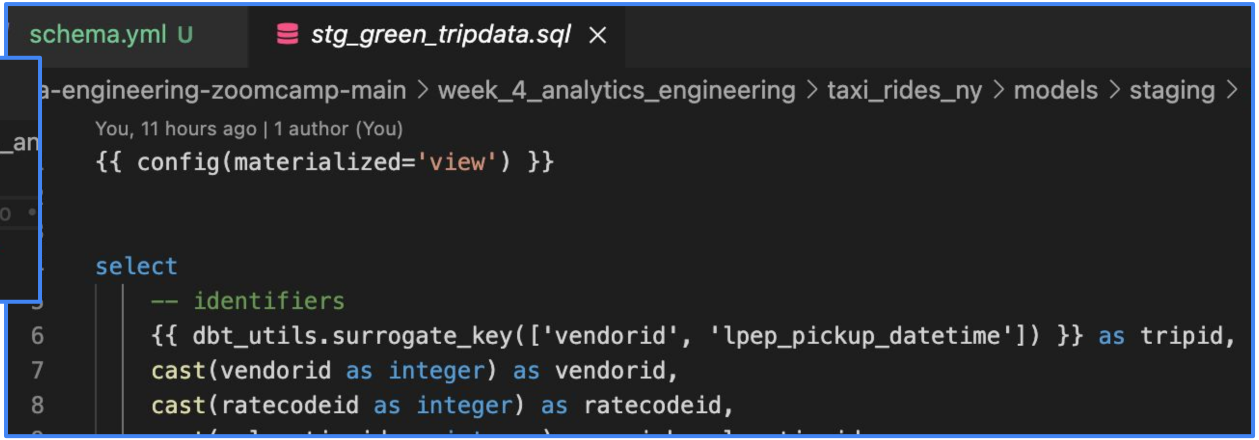
Packages

- Like libraries in other programming languages
- Standalone dbt projects, with models and macros that tackle a specific problem area.
- By adding a package to your project, the package's models and macros will become part of your own project.
- Imported in the **packages.yml** file and imported by running `dbt deps`
- A list of useful packages can be find in [dbt package hub]


schema.yml U
packages.yml
data-engineering-zoomcamp-main > week_4_an
You, a month ago | 1 author (You)
You, 2 months ago

```yaml
packages:
  - package: dbt-labs/dbt_utils
    version: 0.8.0
```

Specifications of the packages to import in the project

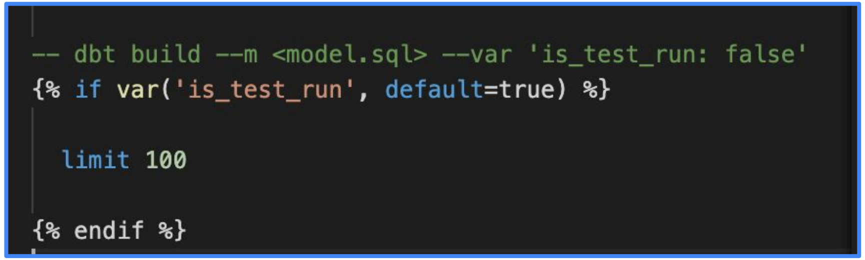

schema.yml U
stg_green_tripdata.sql
a-engineering-zoomcamp-main > week_4_analytics_engineering > taxi_rides_ny > models > staging >
You, 11 hours ago | 1 author (You)

```sql
{{ config(materialized='view') }}


select
    -- identifiers
    {{ dbt_utils.surrogate_key(['vendorid', 'lpep_pickup_datetime']) }} as tripid,
    cast(vendorid as integer) as vendorid,
    cast(ratecodeid as integer) as ratecodeid,
```

Usage of a macro from a package

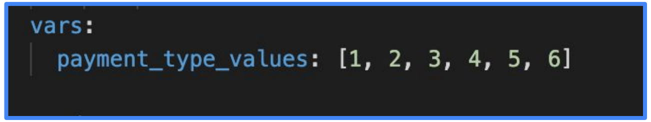
Variables

- Variables are useful for defining values that should be used across the project
- With a macro, dbt allows us to provide data to models for compilation
- To use a variable we use the `{{ var('...') }}` function
- Variables can defined in two ways:
  - In the dbt_project.yml file
  - On the command line



```
-- dbt build --m <model.sql> --var 'is_test_run: false'
{% if var('is_test_run', default=true) %}

  limit 100

{% endif %}
```

Variable whose value we can change via CLI



```
vars:
  payment_type_values: [1, 2, 3, 4, 5, 6]
```

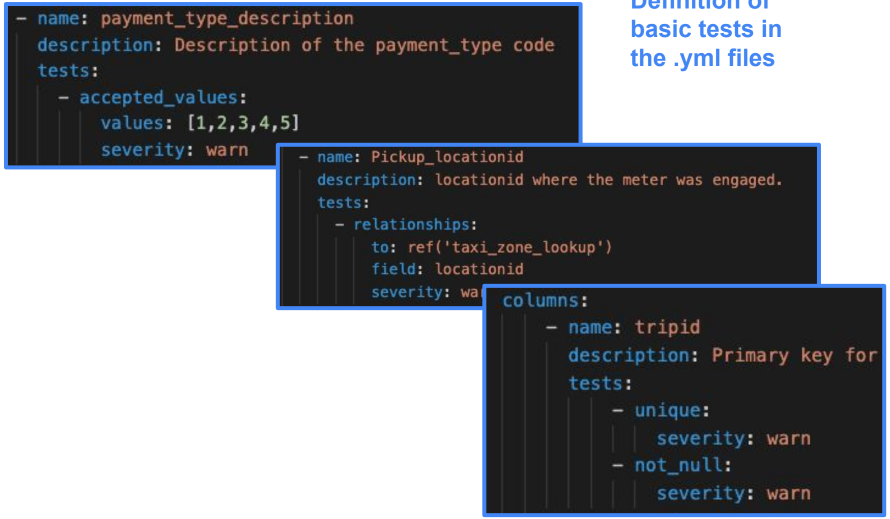
Global variable we define under project.yml

6

Testing and documenting dbt models

Tests

- Assumptions that we make about our data
- Tests in dbt are essentially a `select` sql query
- These assumptions get compiled to sql that returns the amount of failing records
- Test are defined on a column in the .yml file
- dbt provides basic tests to check if the column values are:
  - Unique
  - Not null
  - Accepted values
  - A foreign key to another table
- You can create your custom tests as queries

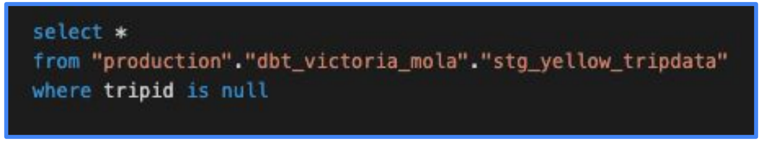


```
- name: payment_type_description
  description: Description of the payment_type code
  tests:
    - accepted_values:
        values: [1,2,3,4,5]
        severity: warn
```

```
- name: Pickup_locationid
  description: locationid where the meter was engaged.
  tests:
    - relationships:
        to: ref('taxi_zone_lookup')
        field: locationid
        severity: wa
```

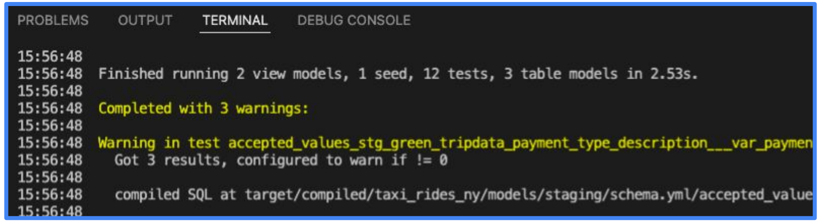
```
columns:
    - name: tripid
      description: Primary key for
      tests:
        - unique:
            severity: warn
        - not_null:
            severity: warn
```

Definition of basic tests in the .yml files



```
select *
from "production"."dbt_victoria_mola"."stg_yellow_tripdata"
where tripid is null
```

Compiled code of the not_null test

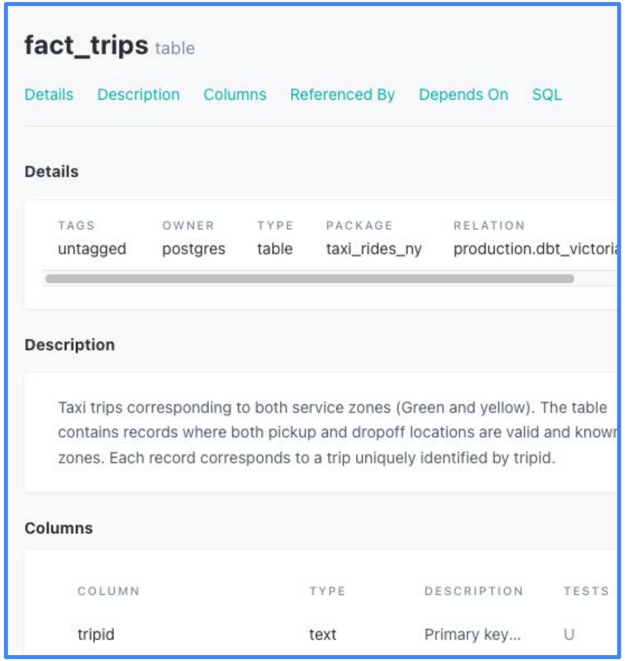


```
15:56:48
15:56:48  Finished running 2 view models, 1 seed, 12 tests, 3 table models in 2.53s.
15:56:48
15:56:48  Completed with 3 warnings:
15:56:48
15:56:48  Warning in test accepted_values_stg_green_tripdata_payment_type_description__var_paymen
15:56:48    Got 3 results, configured to warn if != 0
15:56:48
15:56:48    compiled SQL at target/compiled/taxi_rides_ny/models/staging/schema.yml/accepted_value
15:56:48
```

Warnings in the CLI from running dbt test

Documentation

- dbt provides a way to generate documentation for your dbt project and render it as a website.
- The documentation for your project includes:
  - **Information about your project**:
    - Model code (both from the .sql file and compiled)
    - Model dependencies
    - Sources
    - Auto generated DAG from the ref and source macros
    - Descriptions (from .yml file) and tests
  - **Information about your data warehouse (information_schema):**
    - Column names and data types
    - Table stats like size and rows
- dbt docs can also be hosted in dbt cloud



fact_trips table

Details

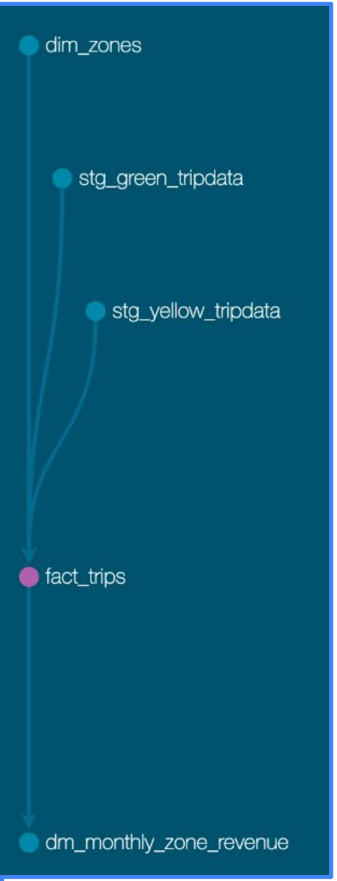
TAGS	OWNER	TYPE	PACKAGE	RELATION
untagged	postgres	table	taxi_rides_ny	production.dbt_victori

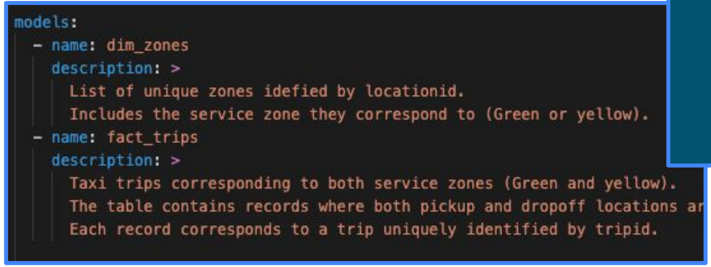
Description

Taxi trips corresponding to both service zones (Green and yellow). The table contains records where both pickup and dropoff locations are valid and know zones. Each record corresponds to a trip uniquely identified by tripid.

Columns

COLUMN	TYPE	DESCRIPTION	TESTS
tripid	text	Primary key...	U





```
models:
  - name: dim_zones
    description: >
      List of unique zones idefied by locationid.
      Includes the service zone they correspond to (Green or yellow).
  - name: fact_trips
    description: >
      Taxi trips corresponding to both service zones (Green and yellow).
      The table contains records where both pickup and dropoff locations ar
      Each record corresponds to a trip uniquely identified by tripid.
```

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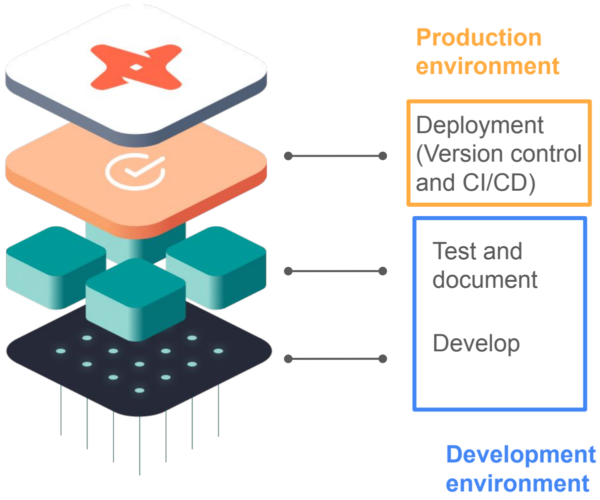
Deployment of a dbt project

What is deployment?

- Process of running the models we created in our development environment in a production environment
- Development and later deployment allows us to continue building models and testing them without affecting our production environment
- A deployment environment will normally have a different schema in our data warehouse and ideally a different user
- A development - deployment workflow will be something like:
  - Develop in a user branch
  - Open a PR to merge into the main branch
  - Merge the branch to the main branch
  - Run the new models in the production environment using the main branch
  - Schedule the models



Production environment

Deployment (Version control and CI/CD)

Test and document

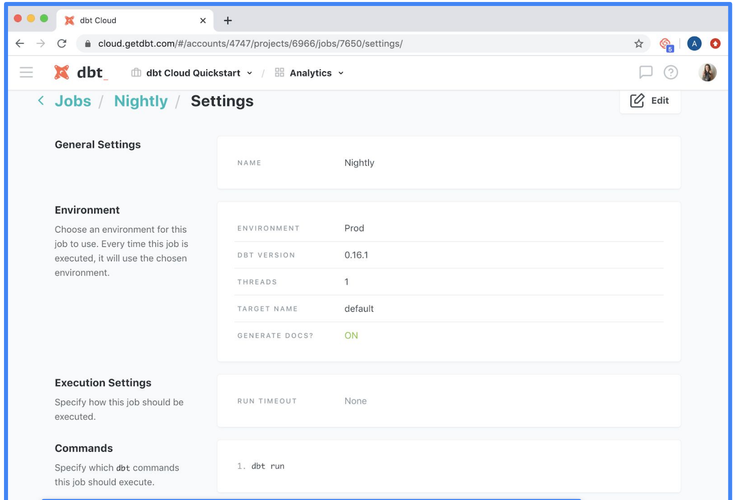
Develop

Development environment

Image: getdbt.com

Running a dbt project in production

- dbt cloud includes a scheduler where to create jobs to run in production
- A single job can run multiple commands
- Jobs can be triggered manually or on schedule
- Each job will keep a log of the runs over time
- Each run will have the logs for each command
- A job could also generate documentation, that could be viewed under the run information
- If dbt source freshness was run, the results can also be viewed at the end of a job


dbt Cloud
cloud.getdbt.com/#/accounts/4747/projects/6966/jobs/7650/settings/
dbt_
dbt Cloud Quickstart
Analytics
Edit

Jobs / Nightly / Settings

General Settings

NAME	Nightly

Environment

Choose an environment for this job to use. Every time this job is executed, it will use the chosen environment.

ENVIRONMENT	Prod
DBT VERSION	0.16.1
THREADS	1
TARGET NAME	default
GENERATE DOCS?	ON

Execution Settings

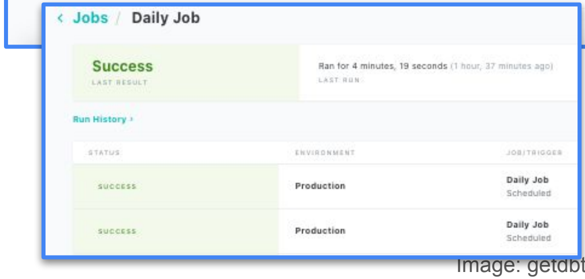
Specify how this job should be executed.

RUN TIMEOUT	None

Commands

Specify which `dbt` commands this job should execute.

```
1. dbt run
```



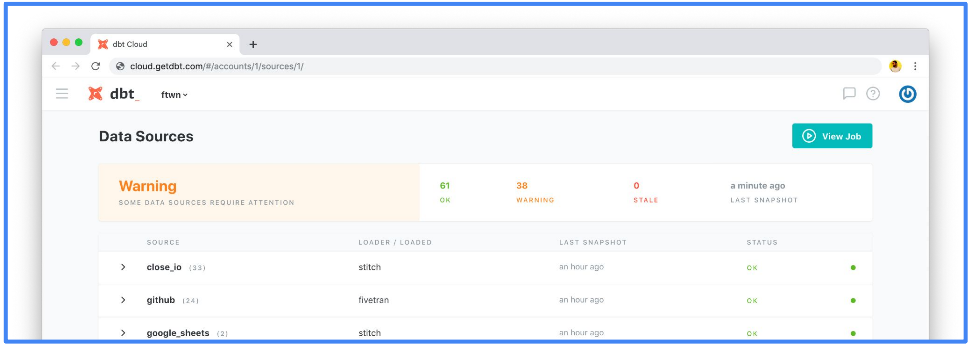
Jobs / Daily Job

Success
LAST RESULT

Ran for 4 minutes, 19 seconds (1 hour, 37 minutes ago)
LAST RUN

Run History ›

STATUS	ENVIRONMENT	JOB/TRIGGER
SUCCESS	Production	Daily Job Scheduled
SUCCESS	Production	Daily Job Scheduled



Data Sources

Warning
SOME DATA SOURCES REQUIRE ATTENTION

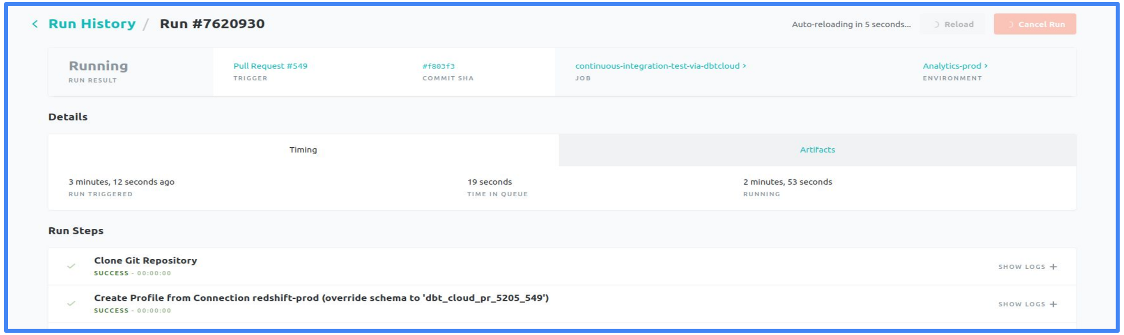
61	38	0	a minute ago
OK	WARNING	STALE	LAST SNAPSHOT

SOURCE	LOADER / LOADED	LAST SNAPSHOT	STATUS	
› close_io (33)	stitch	an hour ago	OK	●
› github (24)	fivetran	an hour ago	OK	●
› google_sheets (2)	stitch	an hour ago	OK	●

Image: getdbt.com

What is Continuous Integration (CI)?

- CI is the practice of regularly merge development branches into a central repository, after which automated builds and tests are run.
- The goal is to reduce adding bugs to the production code and maintain a more stable project.
- dbt allows us to enable CI on pull requests
- Enabled via webhooks from GitHub or GitLab
- When a PR is ready to be merged, a webhooks is received in dbt Cloud that will enqueue a new run of the specified job.
- The run of the CI job will be against a temporary schema
- No PR will be able to be merged unless the run has been completed successfully



Running
RUN RESULT

Pull Request #549
TRIGGER

#f803f3
COMMIT SHA

continuous-integration-test-via-dbtcloud >
JOB

Analytics-prod >
ENVIRONMENT

Details

3 minutes, 12 seconds ago
RUN TRIGGERED

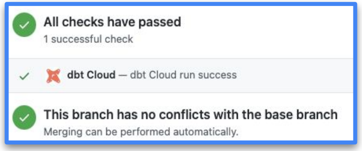
19 seconds
TIME IN QUEUE

2 minutes, 53 seconds
RUNNING

Run Steps

✓ Clone Git Repository
SUCCESS - 00:00:00

✓ Create Profile from Connection redshift-prod (override schema to 'dbt_cloud_pr_5205_549')
SUCCESS - 00:00:00



✓ All checks have passed
1 successful check

✓ dbt Cloud — dbt Cloud run success

✓ This branch has no conflicts with the base branch
Merging can be performed automatically.

Image: getdbt.com

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Visualising the transformed data