# Building an end-to-end open source data platform for clinical data

Alberto Labarga

PyConES Canarias 2023

bsc-health-data / **pycones-23-modern-data-stack**

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# pycones-23-modern-data-stack

Public

forked from bsc-health-data/pydatalondon23-modern-data-stack

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main | 1 branch | 0 tags | Go to file | Add file | Code

This branch is 32 commits ahead of bsc-health-data:main.

Contribute | Sync fork

**alabarga** Update README.md `5b0283a` yesterday **108** commits

| | | |
|---|---|---|
| database | Add database DOckerfile | last year |
| datahub | Add datahub | last year |
| dremio | Add files | last year |
| meltano | Add DBT project | 5 months ago |
| obevo | Add obevo schemas | last year |

https://github.com/bsc-health-data/pycones-23-modern-data-stack/

Telecommunications Engineer
Working as Head of Health Data @BSC
More than 20 years teaching

open data - open source – open science

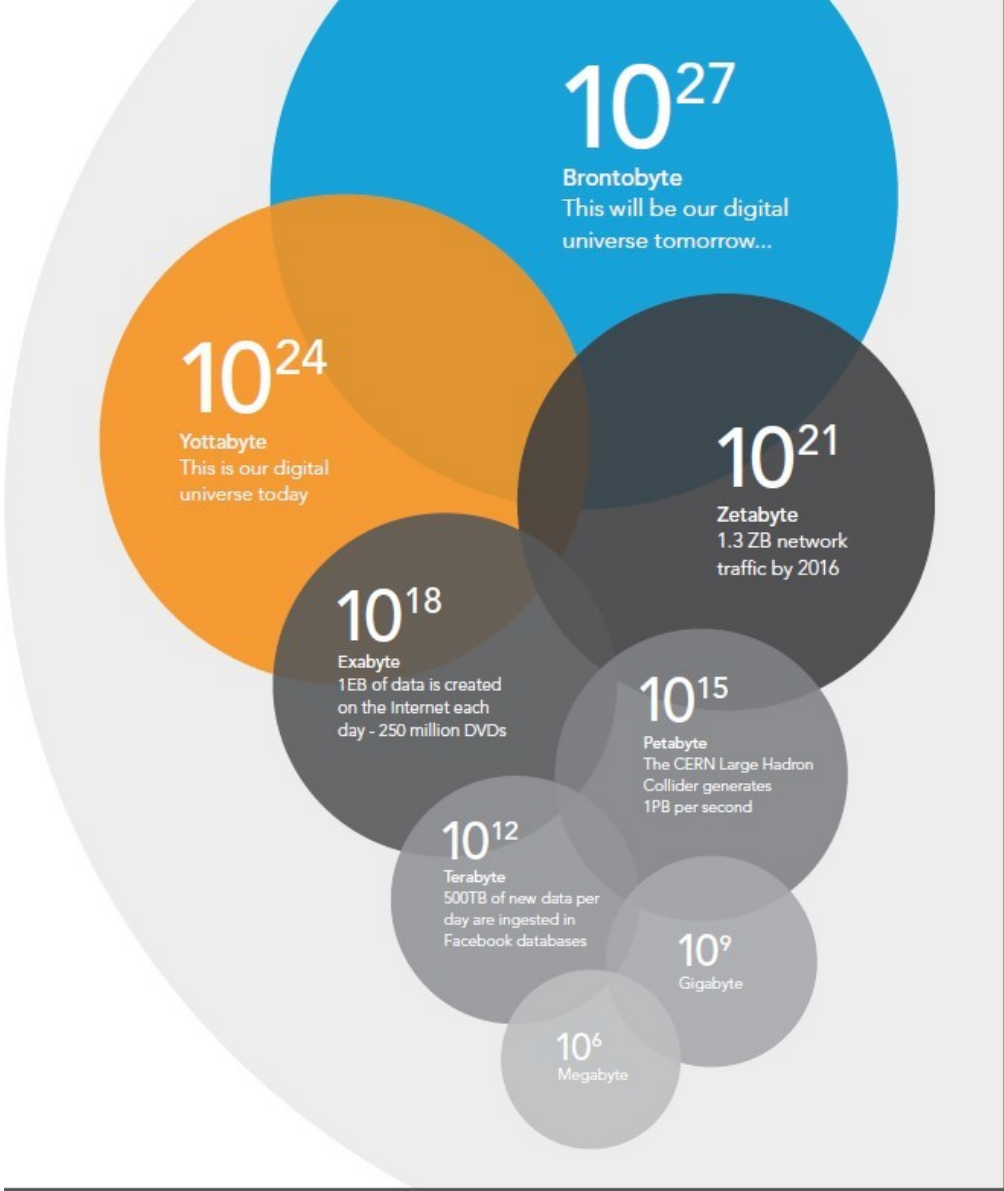
# I am Alberto

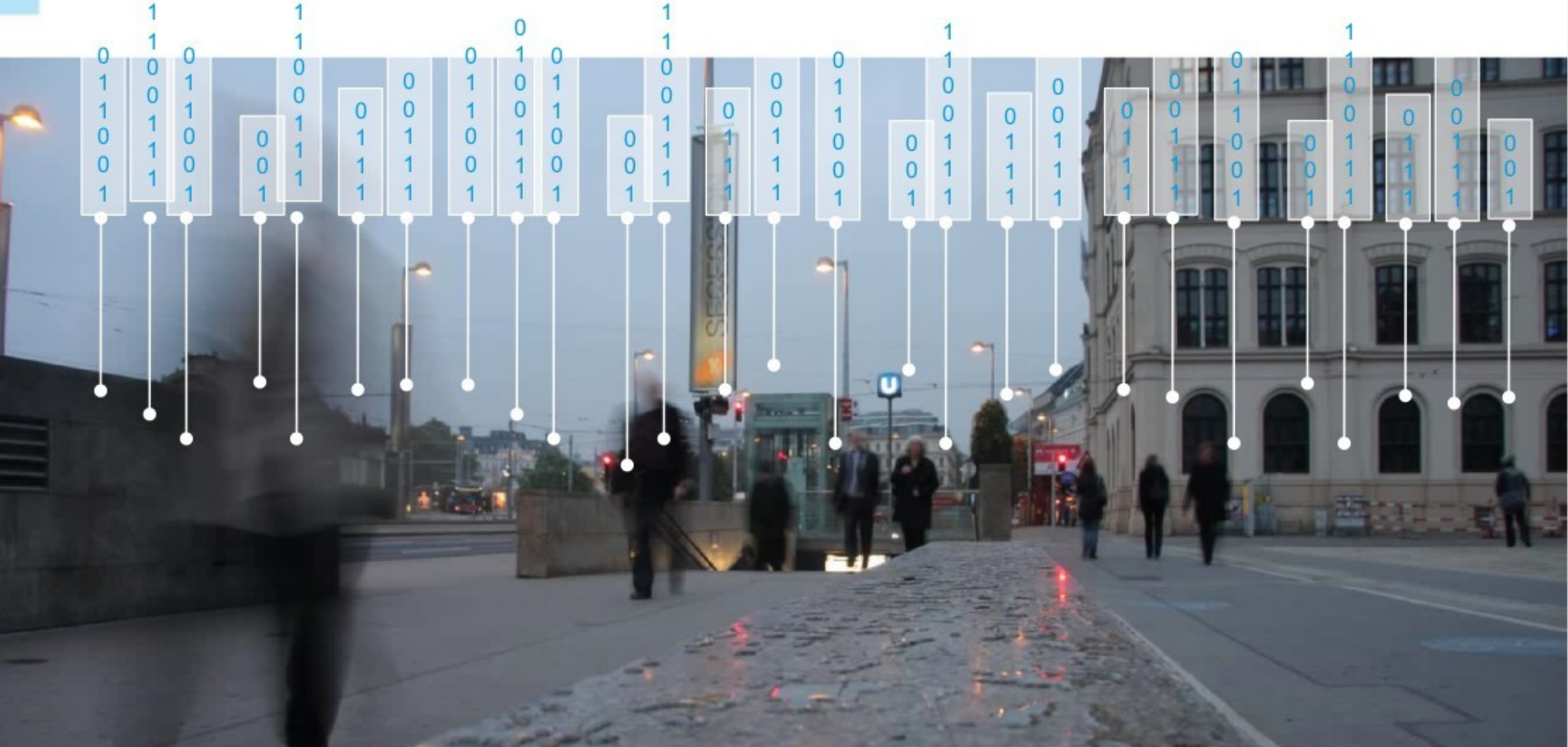
alabarga
alabarga
/in/albertolabarga

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

My God, it’s full of data!

# Data is big


$10^{27}$
Brontobyte
This will be our digital universe tomorrow...
$10^{24}$
Yottabyte
This is our digital universe today
$10^{21}$
Zetabyte
1.3 ZB network traffic by 2016
$10^{18}$
Exabyte
1EB of data is created on the Internet each day - 250 million DVDs
$10^{15}$
Petabyte
The CERN Large Hadron Collider generates 1PB per second
$10^{12}$
Terabyte
500TB of new data per day are ingested in Facebook databases
$10^{9}$
Gigabyte
$10^{6}$
Megabyte



A
B

CLOSED

OPEN

FAIR

# What is FAIR DATA?

Data and supplementary materials have sufficiently rich metadata and a unique and persistent identifier.

**FINDABLE**

Metadata and data are understandable to humans and machines. Data is deposited in a trusted repository.

**ACCESSIBLE**

Metadata use a formal, accessible, shared, and broadly applicable language for knowledge representation.

**INTEROPERABLE**

Data and collections have a clear usage licenses and provide accurate information on provenance.

**REUSABLE**

# (Clinical) Data is complicated

IBSAL Instituto de Investigación Biomédica de Salamanca

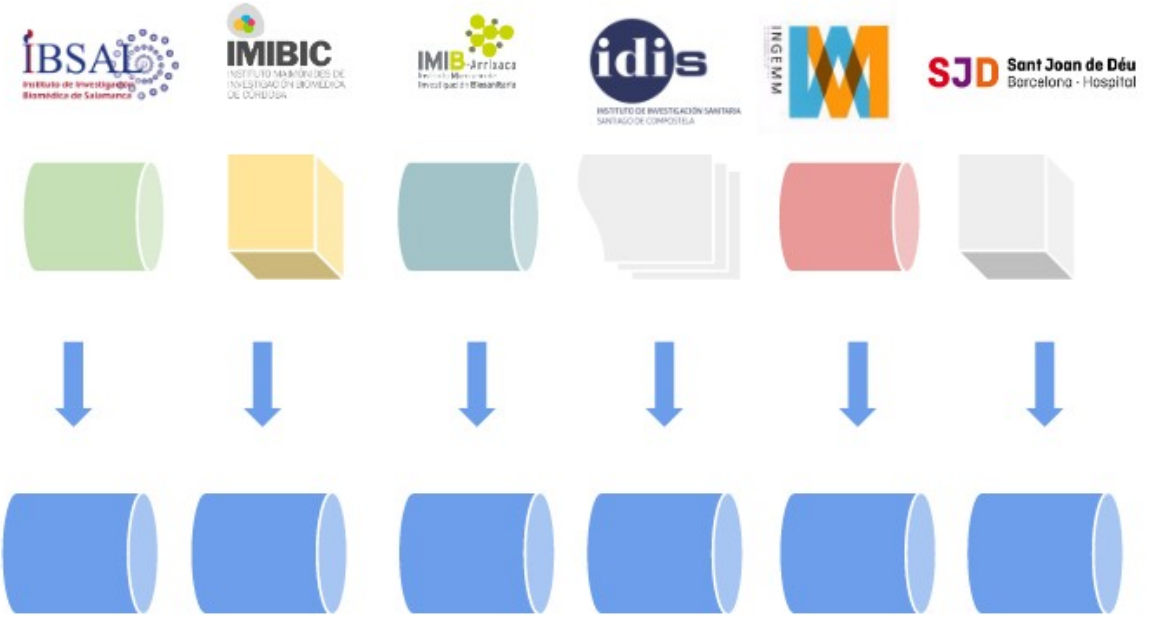
IMIBIC Instituto Maimónides de Investigación Biomédica de Córdoba

IMIB-Arrixaca Instituto Murciano de Investigación Biosanitaria

idis Instituto de Investigación Sanitaria Santiago de Compostela

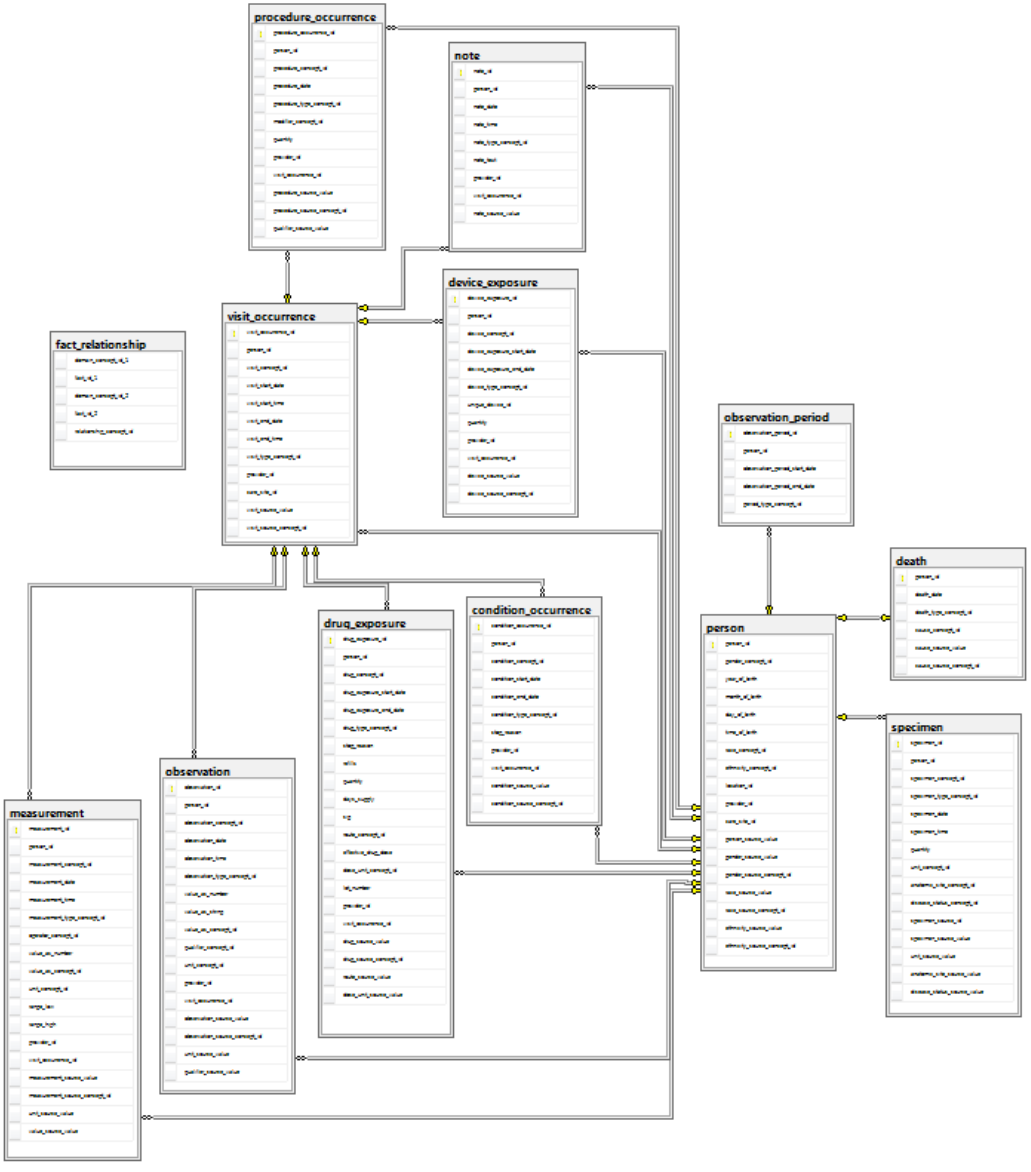
INGEMM

SJD Sant Joan de Déu Barcelona - Hospital


IBSAL
Instituto de Investigación Biomédica de Salamanca
IMIBIC
INSTITUTO MAIMÓNIDES DE INVESTIGACIÓN BIOMÉDICA DE CÓRDOBA
IMIB-Arrixaca
idis
INSTITUTO DE INVESTIGACIÓN SANITARIA SANTIAGO DE COMPOSTELA
INGEMM
SJD
Sant Joan de Déu
Barcelona - Hospital

OHDSI

OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS




https://ohdsi.github.io/CommonDataModel/

ATHENA

SEARCH | DOWNLOAD | Alberto Labarga

SEARCH BY KEYWORD

cancer

cancer ×

Standard ×

DOWNLOAD RESULTS

Show by 15 items Total 8,007 items

1 2 3 4 5 ... 534

- DOMAIN
- CONCEPT
  - Classification (346)
  - Non-standard (5079)
  - Standard (8007)
- CLASS
- VOCAB
- VALIDITY

| ID | CODE | NAME | CLASS | CONCEPT | VALIDITY | DOMAIN | VOCAB |
|---|---|---|---|---|---|---|---|
| 45877275 | LA10524-9 | Cancer | Answer | Standard | Valid | Meas Value | LOINC |
| 4194405 | 395099008 | Cancer confirmed | Context-dependent | Standard | Valid | Condition | SNOMED |
| 4299598 | 386604001 | Cancer registrar | Social Context | Standard | Valid | Observation | SNOMED |
| 1384523 | CancerConditions_NoCancer | Cancer Conditions: No Cancer | Answer | Standard | Valid | Observation | PPI |
| 4073624 | 243072006 | Cancer education | Procedure | Standard | Valid | Procedure | SNOMED |
| 44803809 | 722731000000100 | Colorectal cancer | Qualifier Value | Standard | Valid | Observation | SNOMED |
| 40757663 | 54532-7 | Cancer | Survey | Standard | Valid | Observation | LOINC |

https://athena.ohdsi.org

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idis
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IMIBIC
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# Modern data stack

Supreme
PWS
Regular
93
89
87

19
16
20

The **modern data stack** is one **framework** used to **conceptualize** how different **data tools** work together to allow a complete **data journey**.

# Modern Data Stack

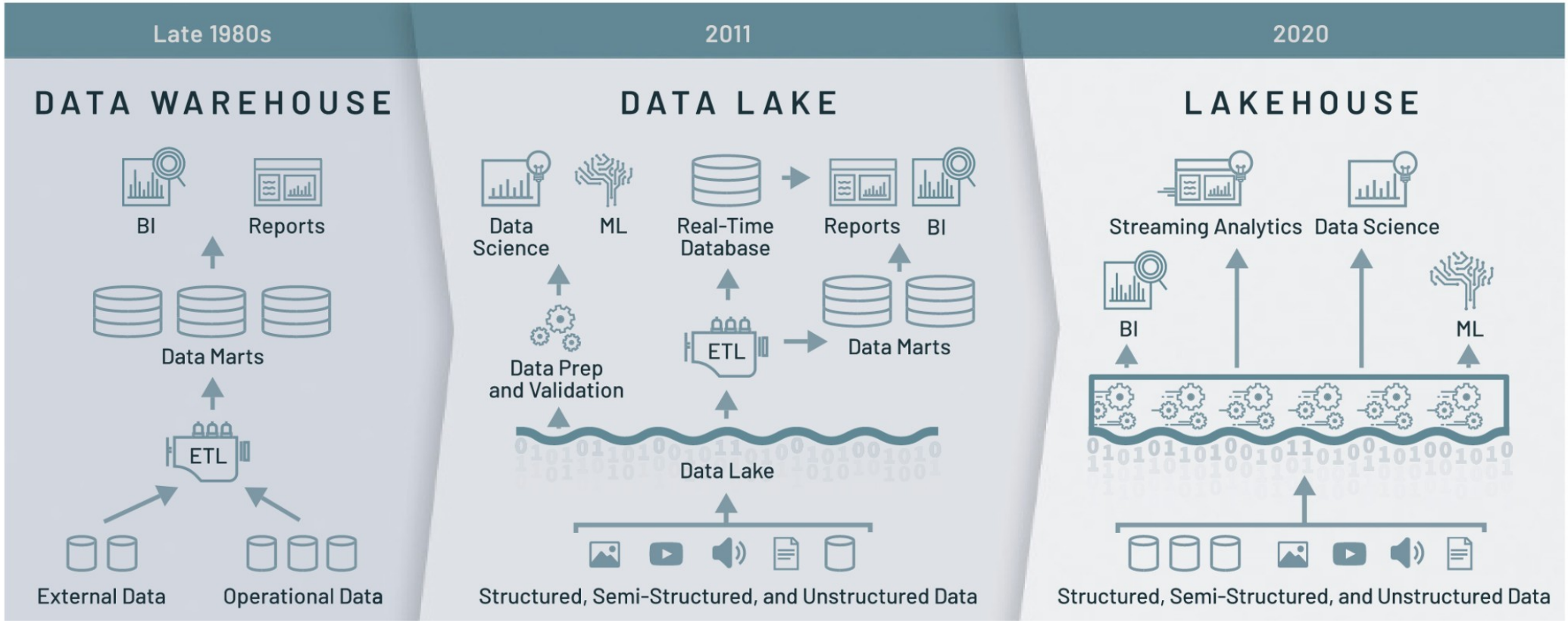
- **Infraestructure as code**

HELM

Build
Release
Deploy
build
release
deploy_produc...
deploy_staging

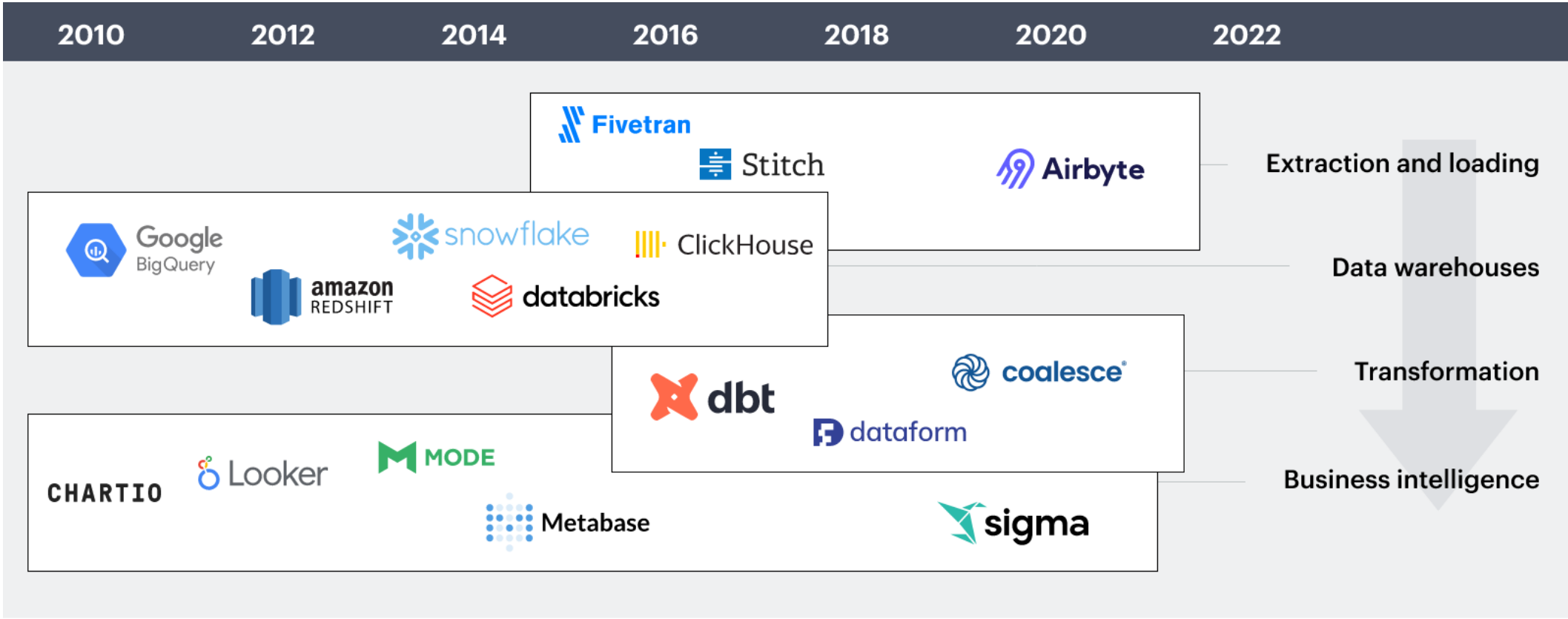
# Modern Data Stack

- Infraestructure as code
- **From Datawarehouse to Lakehouse**


Late 1980s
2011
2020
DATA WAREHOUSE
BI
Reports
Data Marts
ETL
External Data
Operational Data
DATA LAKE
Data Science
ML
Real-Time Database
Reports
BI
Data Prep and Validation
ETL
Data Marts
Data Lake
Structured, Semi-Structured, and Unstructured Data
LAKEHOUSE
Streaming Analytics
Data Science
BI
ML
Structured, Semi-Structured, and Unstructured Data

# Modern Data Stack

- Infraestructure as code
- From Datawarehouse to Lakehouse
- **From ETL to ELT**

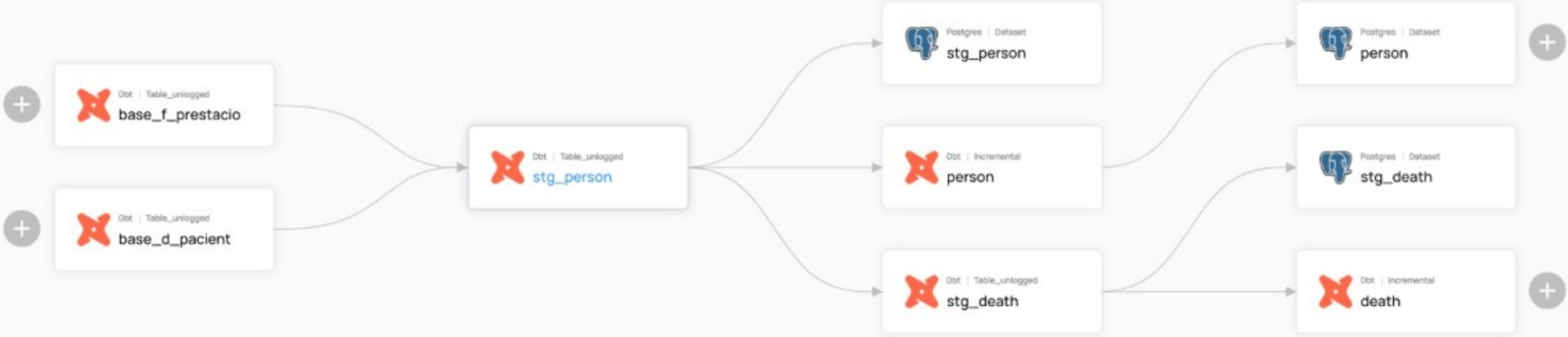



# Adoption of the **Modern Data Stack**

Helps data teams pull data from sources (**extraction and loading**) into one place (**warehouses**), transform it into a usable form (**transformation**), and then give access with accessible tools (**business intelligence**).

# Modern Data Stack

- Infraestructure as code
- From Datawarehouse to Lakehouse
- From ETL to ELT
- **Data governance and observability**



**Accuracy**
The degree to which the data correctly represents the entity or attribute being described.

**Completeness**
The percentage of missing data from a given data set.

**Consistency**
The absence of difference or contradiction in data irrespective of the data's source.

**Validity**
Invalid data affects the accuracy and completeness of a data set.

**Integrity**
The validity of relationships across various data entities.

**Uniqueness**
Ensures duplicate or overlapping data is identified and marked.

# Modern Data Stack

- Infraestructure as code
- From Datawarehouse to Lakehouse
- From ETL to ELT
- Data governance and observability
- **Self-service analytics**

PRODUCTION APPMED

Search by Title...

Recent

PERSON

Person analysis

Domain Visit

DRUGS (QA)

EDA: DRUG_EXPOSURE (H12O)

Favorites ↓U@

No items in this section.

Lists

OMOP

All My Docs ↓U@

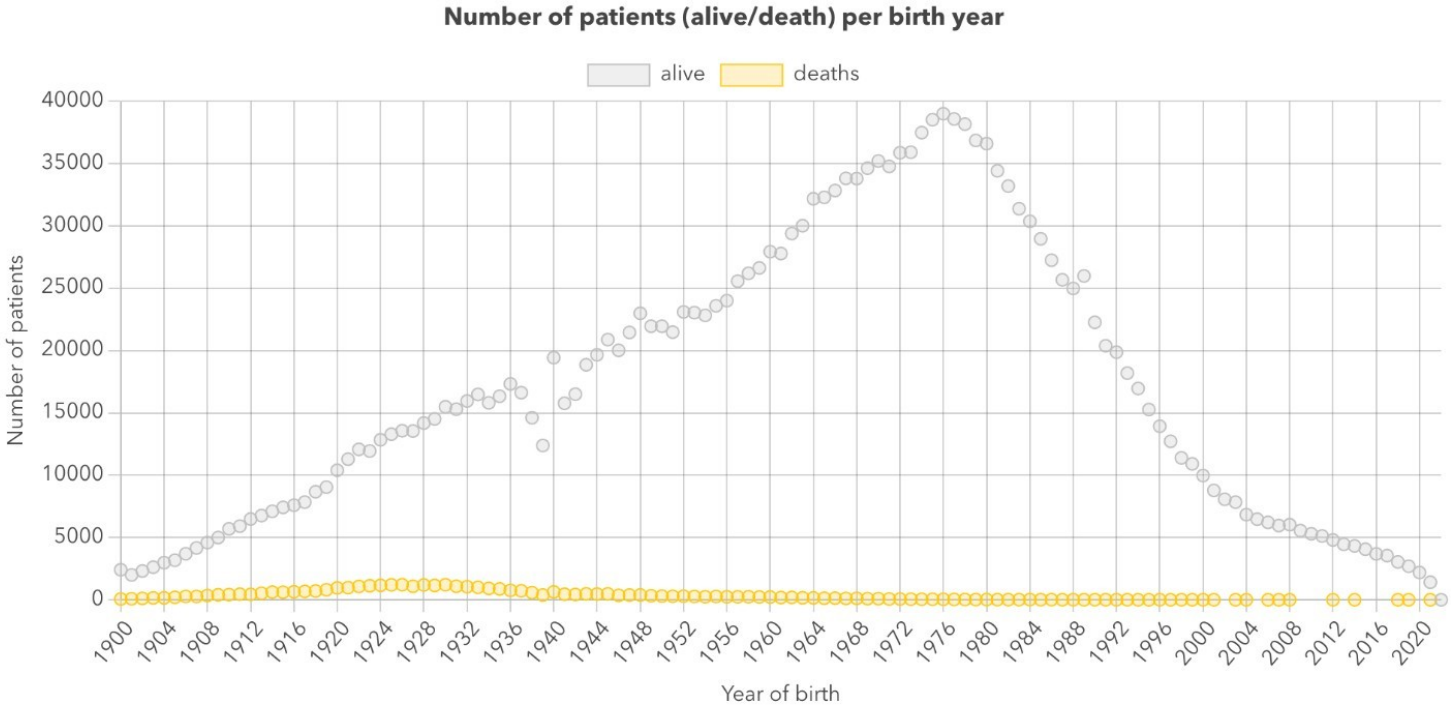
*Untitled*

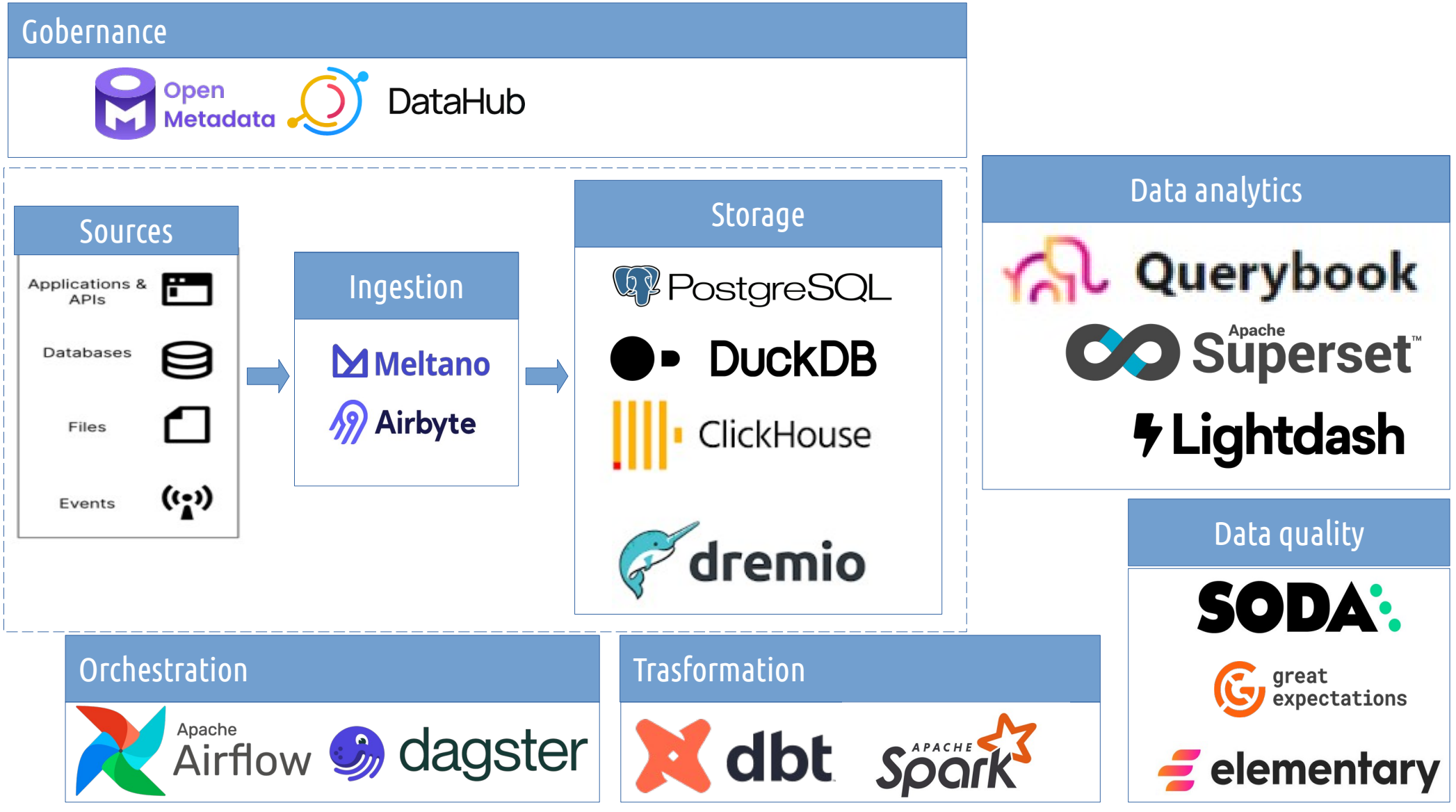
Adhoc Docs Tables Snippets Runs Search

EXECUTION 90

STATEMENT 1 OUT OF 1

CONFIG CHART




Gobernance
Open Metadata
DataHub
Sources
Applications & APIs
Databases
Files
Events
Ingestion
Meltano
Airbyte
Storage
PostgreSQL
DuckDB
ClickHouse
dremio
Data analytics
Querybook
Apache Superset
Lightdash
Data quality
SODA
great expectations
elementary
Orchestration
Apache Airflow
dagster
Trasformation
dbt
APACHE Spark

# Practice time?

bsc-health-data / **pycones-23-modern-data-stack**

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# pycones-23-modern-data-stack

Public

forked from bsc-health-data/pydatalondon23-modern-data-stack

Edit Pins | Watch 0

main | 1 branch | 0 tags | Go to file | Add file | Code

This branch is 32 commits ahead of bsc-health-data:main.

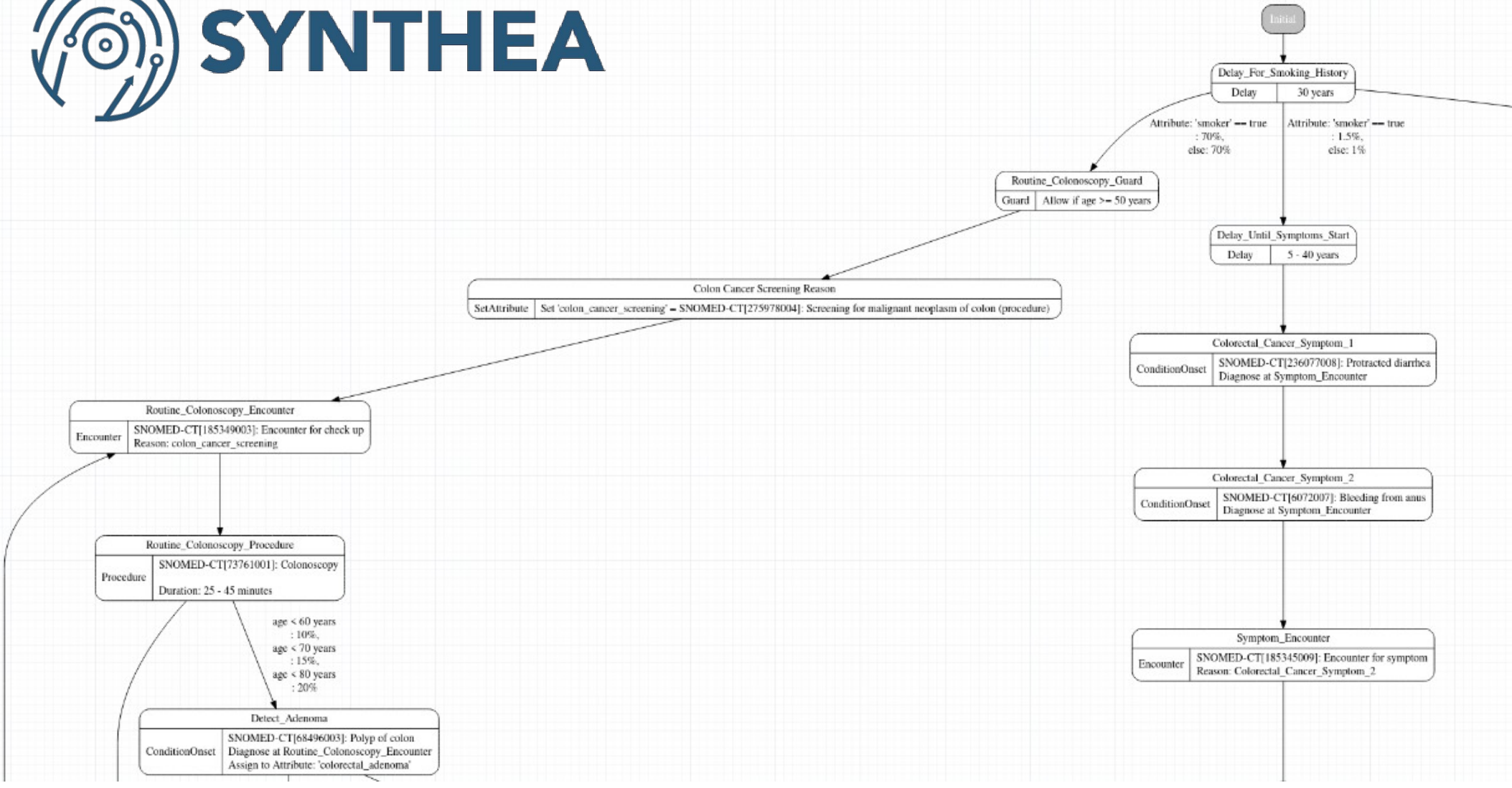
Contribute | Sync fork

**alabarga** Update README.md `5b0283a` yesterday **108** commits

| | | |
|---|---|---|
| database | Add database DOckerfile | last year |
| datahub | Add datahub | last year |
| dremio | Add files | last year |
| meltano | Add DBT project | 5 months ago |
| obevo | Add obevo schemas | last year |

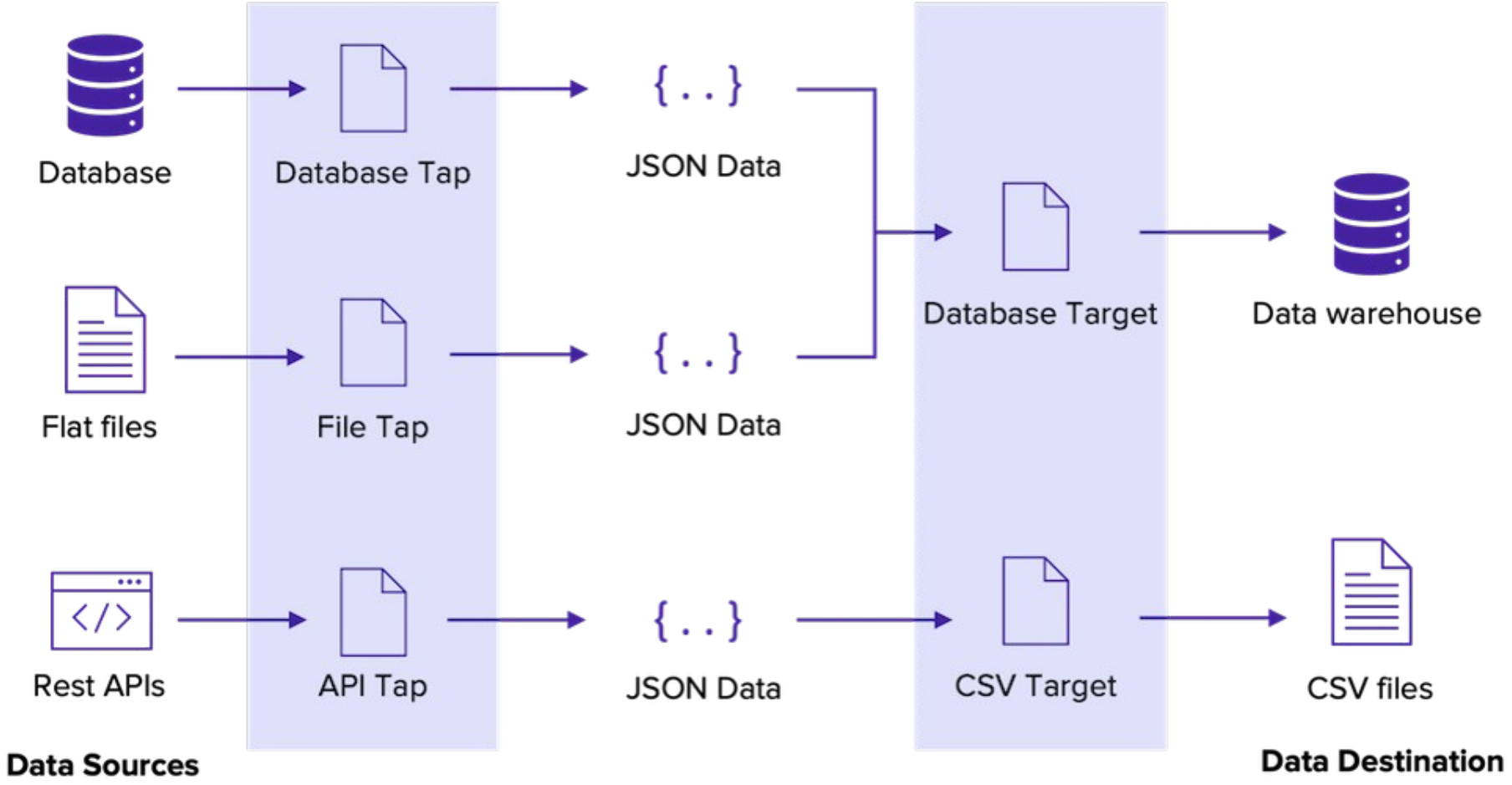
https://github.com/bsc-health-data/pycones-23-modern-data-stack/

# SYNTHEA


Initial
Delay_For_Smoking_History
Delay
30 years
Attribute: 'smoker' == true
: 70%,
else: 70%
Attribute: 'smoker' == true
: 1.5%,
else: 1%
Routine_Colonoscopy_Guard
Guard
Allow if age >= 50 years
Delay_Until_Symptoms_Start
Delay
5 - 40 years
Colon Cancer Screening Reason
SetAttribute
Set 'colon_cancer_screening' = SNOMED-CT[275978004]: Screening for malignant neoplasm of colon (procedure)
Colorectal_Cancer_Symptom_1
ConditionOnset
SNOMED-CT[236077008]: Protracted diarrhea
Diagnose at Symptom_Encounter
Routine_Colonoscopy_Encounter
Encounter
SNOMED-CT[185349003]: Encounter for check up
Reason: colon_cancer_screening
Colorectal_Cancer_Symptom_2
ConditionOnset
SNOMED-CT[6072007]: Bleeding from anus
Diagnose at Symptom_Encounter
Routine_Colonoscopy_Procedure
Procedure
SNOMED-CT[73761001]: Colonoscopy
Duration: 25 - 45 minutes
age < 60 years
: 10%,
age < 70 years
: 15%,
age < 80 years
: 20%
Symptom_Encounter
Encounter
SNOMED-CT[185345009]: Encounter for symptom
Reason: Colorectal_Cancer_Symptom_2
Detect_Adenoma
ConditionOnset
SNOMED-CT[68496003]: Polyp of colon
Diagnose at Routine_Colonoscopy_Encounter
Assign to Attribute: 'colorectal_adenoma'

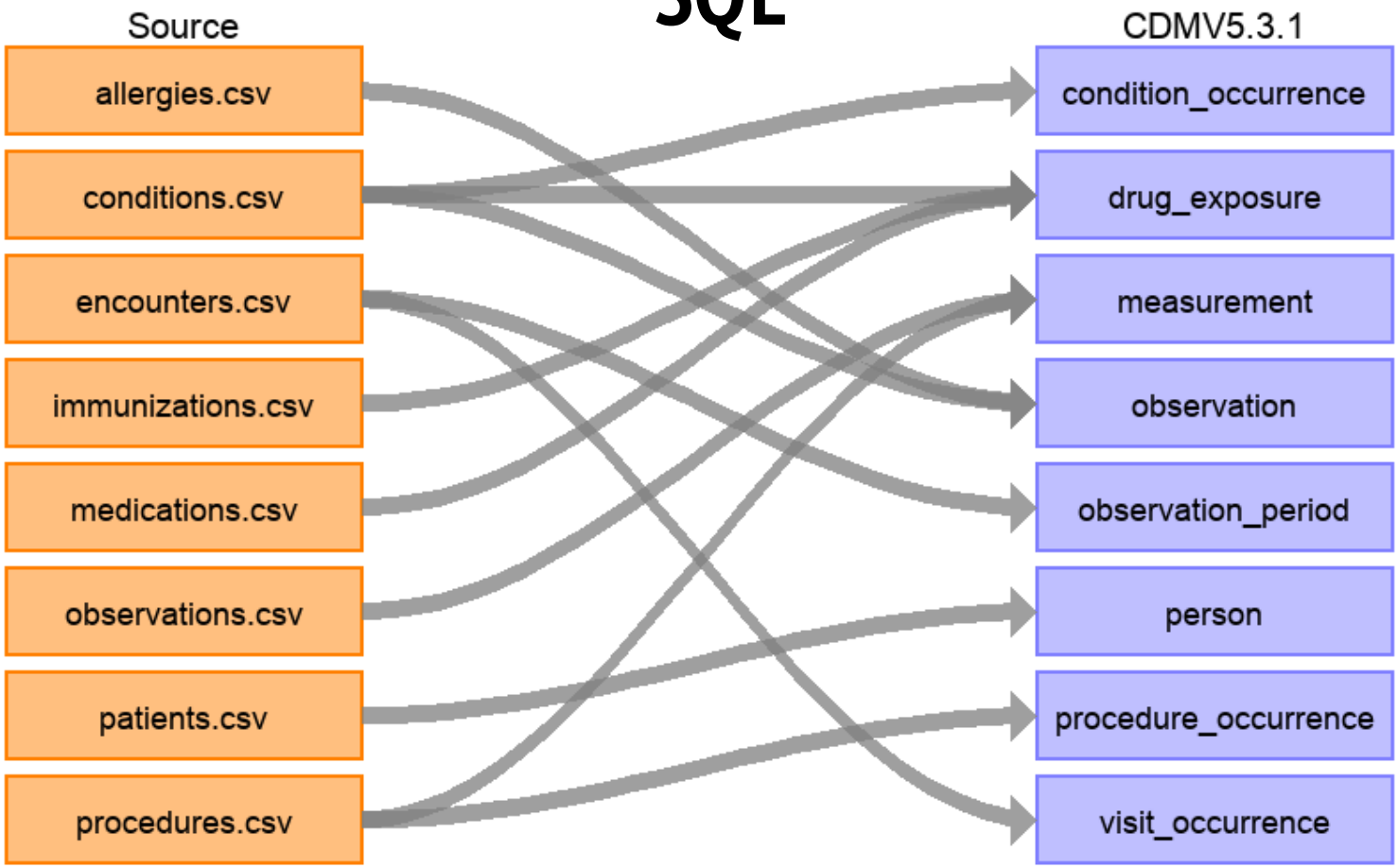
meltano

SINGER

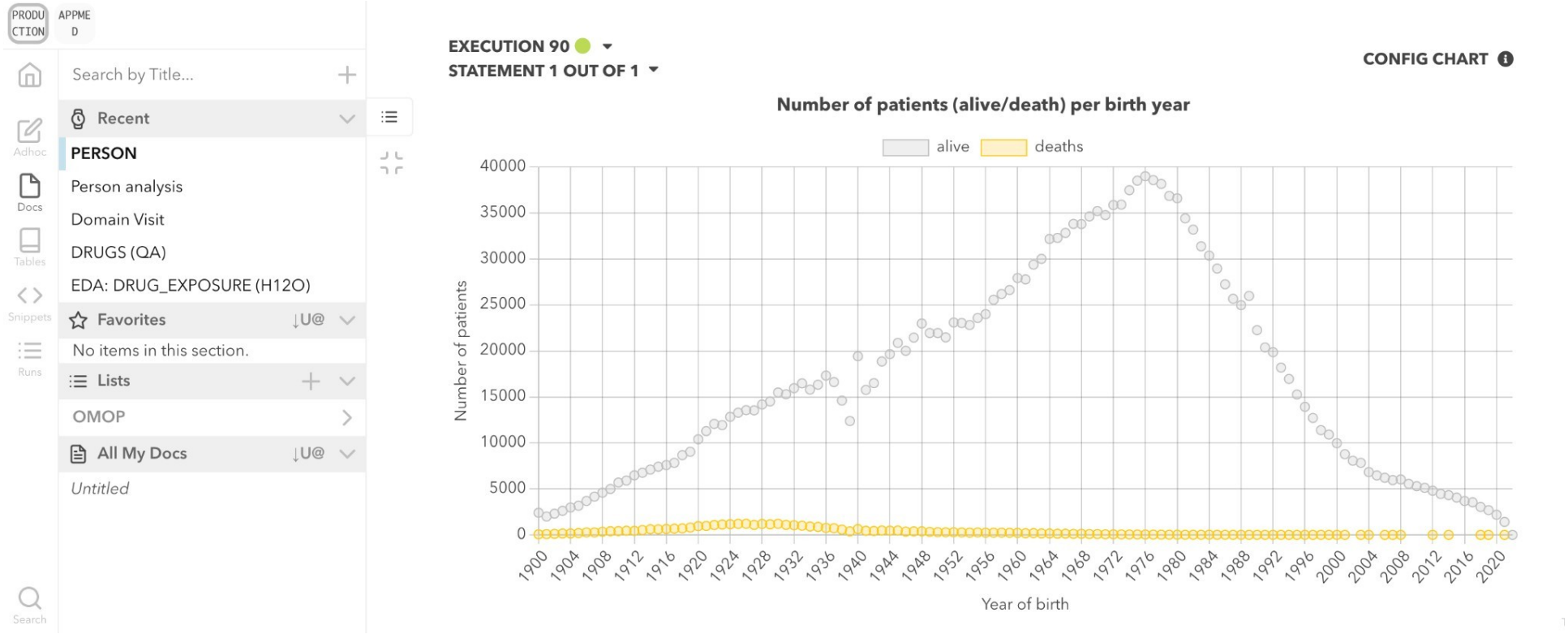


dbt

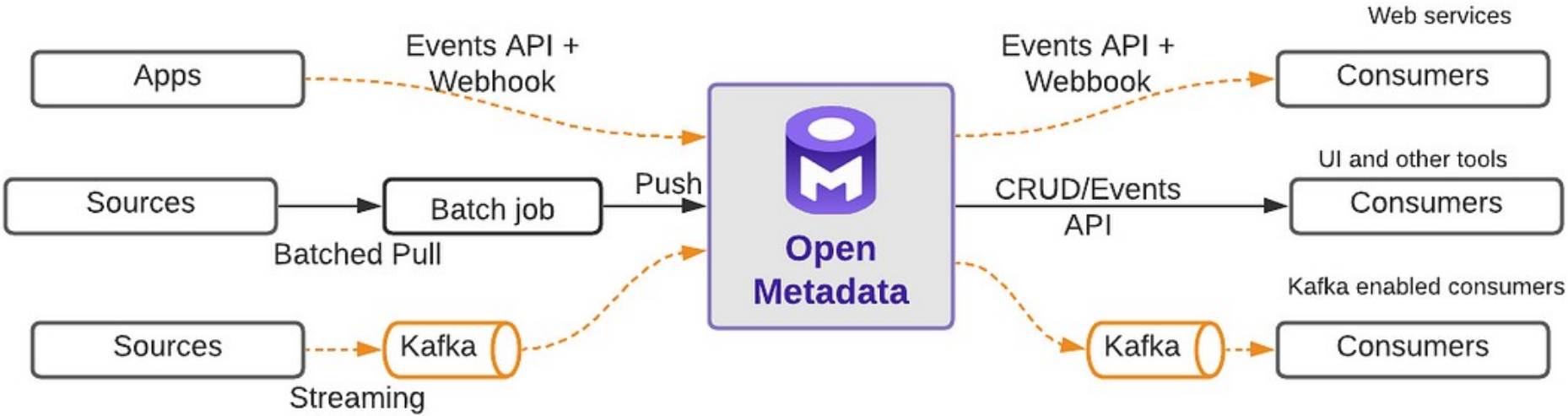
# SQL


Source
allergies.csv
conditions.csv
encounters.csv
immunizations.csv
medications.csv
observations.csv
patients.csv
procedures.csv
CDMV5.3.1
condition_occurrence
drug_exposure
measurement
observation
observation_period
person
procedure_occurrence
visit_occurrence

# Querybook


PRODUCTION
APPMED
Search by Title...
Recent
PERSON
Person analysis
Domain Visit
DRUGS (QA)
EDA: DRUG_EXPOSURE (H12O)
Favorites
No items in this section.
Lists
OMOP
All My Docs
Untitled
Adhoc
Docs
Tables
Snippets
Runs
Search
EXECUTION 90
STATEMENT 1 OUT OF 1
CONFIG CHART
Number of patients (alive/death) per birth year
alive
deaths
Number of patients
Year of birth

Open Metadata

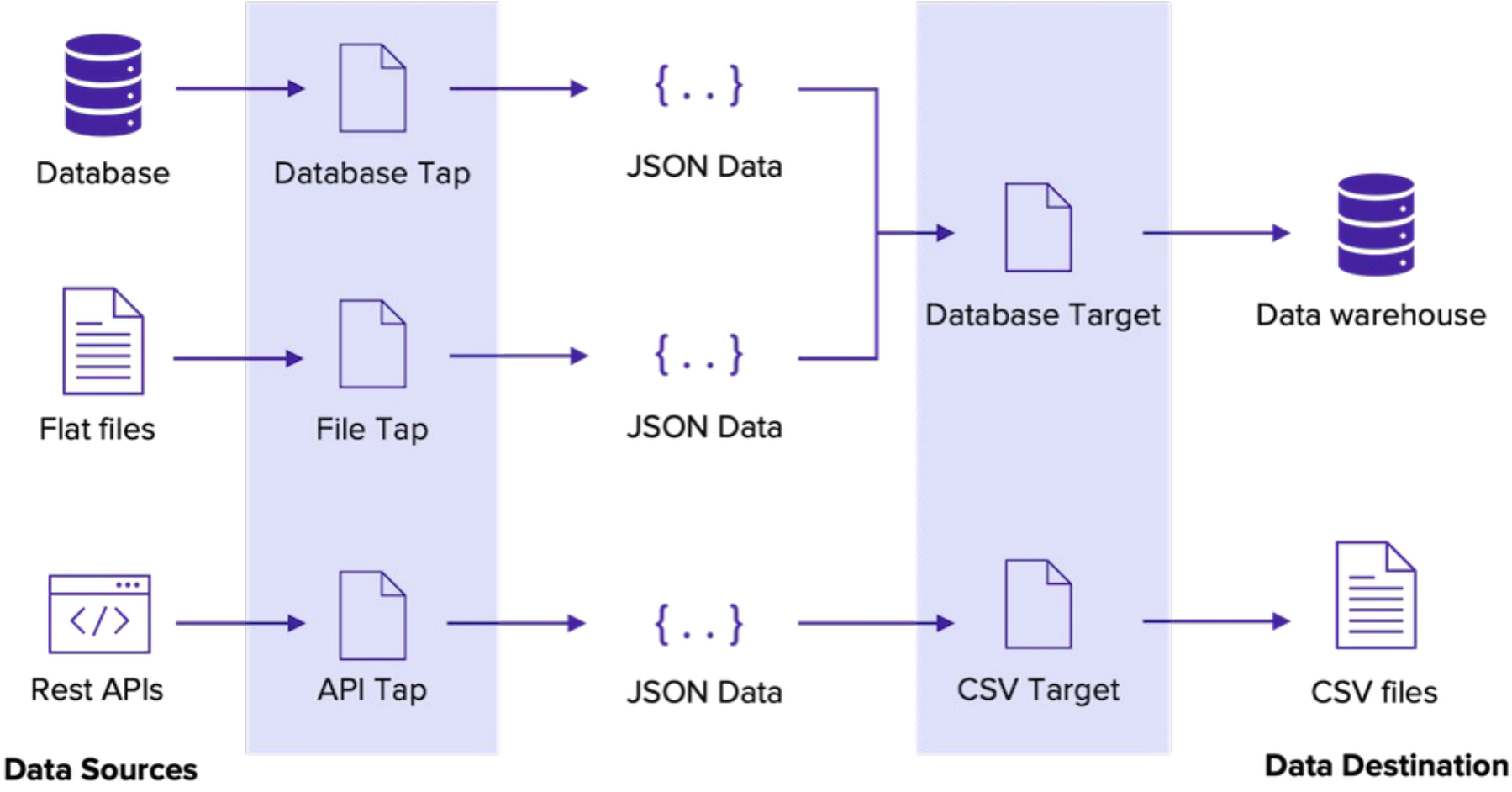



Metadata Ingestion - Pull/Push/Streaming

Metadata Consumption - Pull/Push/Streaming

# What about Python?

SINGER


Database
Database Tap
JSON Data
Flat files
File Tap
JSON Data
Rest APIs
API Tap
JSON Data
Database Target
Data warehouse
CSV Target
CSV files
Data Sources
Data Destination

```python
class TapCSV(Tap):
    """CSV tap class."""

    name = "tap-csv"

    config_jsonschema = th.PropertiesList(
        th.Property(
            "csv_file",
            th.StringType,
            description="A path to the CSV file.",
        )).to_dict()

    def discover_streams(self) -> List[Stream]:
        """Return a list of discovered streams."""
        return [
            CSVStream(
                tap=self,
                name=file_config.get("entity"),
                file_config=file_config,
            )
            for file_config in self.config.get("csv_file")
        ]
```

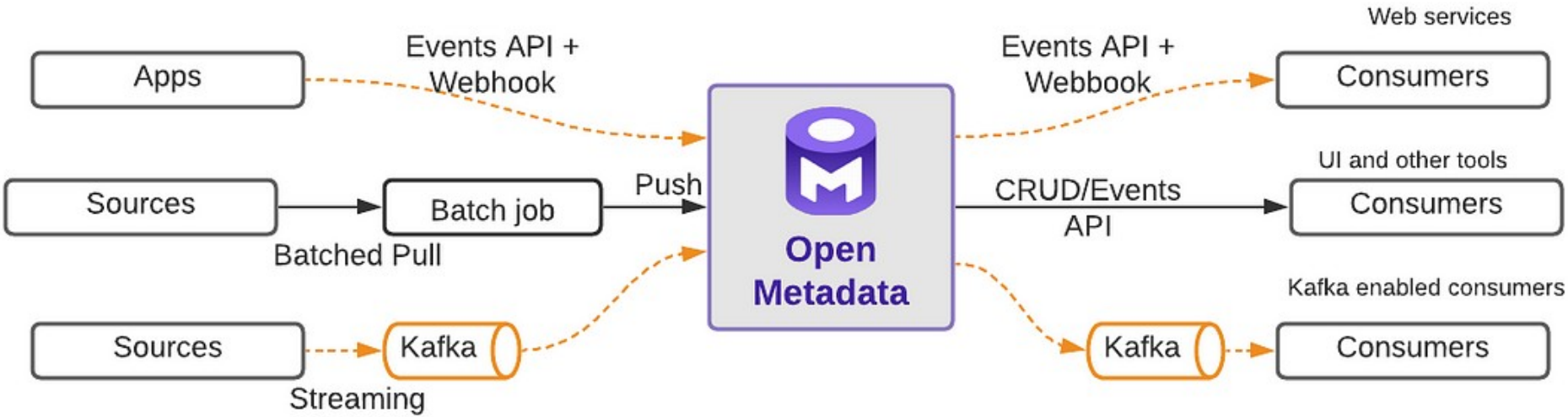
```python
class CSVStream(Stream):
    """Stream class for CSV streams."""
    def get_records(self, context: Optional[dict]) -> Iterable[dict]:
        """Return a generator of row-type dictionary objects.
        """
        for file_path in self.get_file_paths():

            for row in self.get_rows(file_path):

                yield dict(zip(self.header, row))
```

https://gitlab.com/meltano/sdk/-/tree/main/cookiecutter

Snowpark
Databricks cluster
Dataproc
Data Warehouse

```python
def model(dbt, session):

    # DataFrame representing an upstream model
    upstream_model = dbt.ref("upstream_model_name")

    # DataFrame representing an upstream source
    upstream_source = dbt.source("upstream_source_name", "table_name")

    final_df = ...  # stuff you can't write in SQL!

    return final_df

}
```

https://docs.getdbt.com/docs/building-a-dbt-project/building-models/python-models




Metadata Ingestion - Pull/Push/Streaming

Metadata Consumption - Pull/Push/Streaming

```python
metadata = OpenMetadata(server_config)
create_ml_model = CreateMlModelRequest(
    name=raw_meta["name"],
    description=raw_meta["description"],
    algorithm=raw_meta["algorithm"],
    target=raw_meta["target"],
    mlFeatures=[ ...],
    mlHyperParameters=[...],
    mlStore=MlStore(
        storage=raw_meta["mlStore"]["storage"],
        imageRepository=raw_meta["mlStore"]["imageRepository"]
    ),
    service=get_or_create_ml_model_service(metadata, raw_meta["serviceName"])
)
mlmodel: MlModel = metadata.create_or_update(create_ml_model)
```

https://github.com/open-metadata/openmetadata-demo/blob/main/mlmodel-cicd/mlmodel_cicd.py

```python
class MyAwesomeConnector(Source):
    """
    Custom connector to ingest Database metadata
    """

    def __init__(self, config: WorkflowSource, metadata_config: OpenMetadataConnection):
        self.config = config
        self.metadata_config = metadata_config

        self.metadata = OpenMetadata(self.metadata_config)
        self.status = MyAwesomeConnectorStatus()

    @classmethod
    def create(
        cls, config_dict: dict, metadata_config: OpenMetadataConnection
    ) -> "MyAwesomeConnector":
        config: WorkflowSource = WorkflowSource.parse_obj(config_dict)
        return cls(config, metadata_config)


    def next_record(self) -> Iterable[Entity]:
        pass
```

https://github.com/open-metadata/openmetadata-demo/tree/main/custom-connector/

Thanks!