OMOP Common Data Model Extract, Transform & Load

OHDSI Symposium 2022

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Agenda Total time 9:00-10:50

Time	Agenda item
9:00 – 9:25	Introduction to OMOP CDM
9:25 – 9:50	OHDSI ETL Best Practices
9:50 – 10:00	Energy Break
10:00 – 10:25	ETL Exercise
10:25 – 10:50	CDM & Vocabulary Exercise

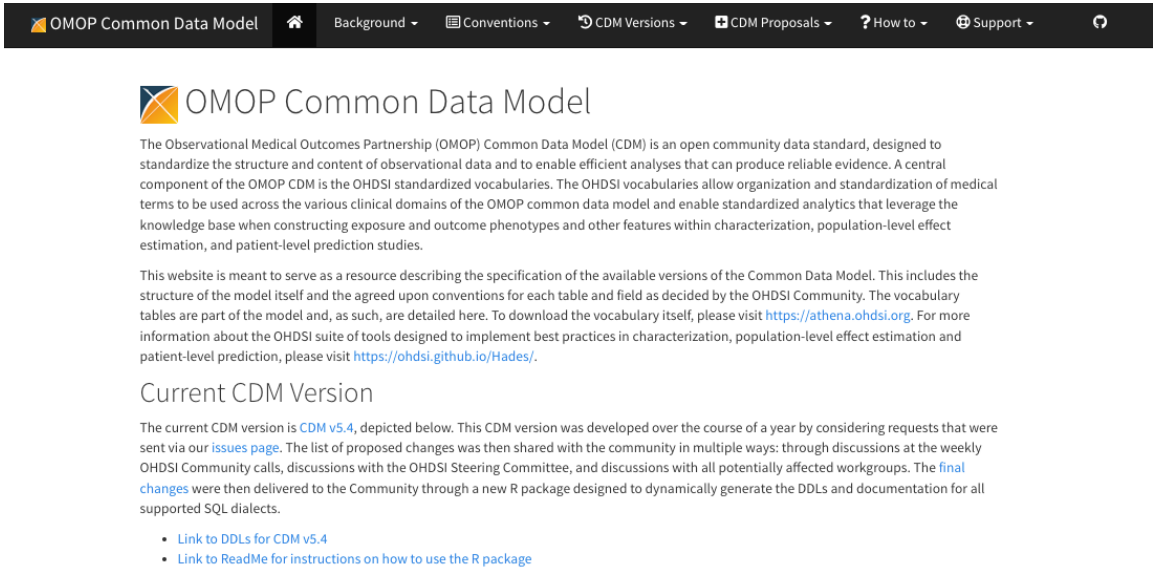
Leads

Clair Blacketer

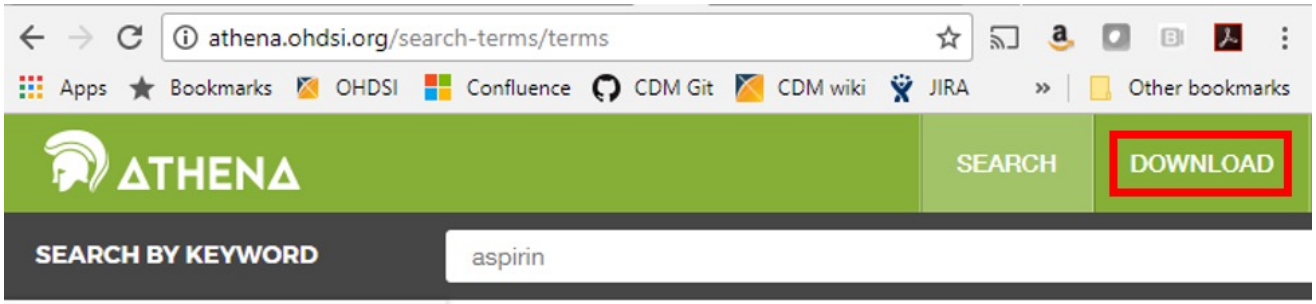
Melanie Philofsky


Helpful Bookmarks

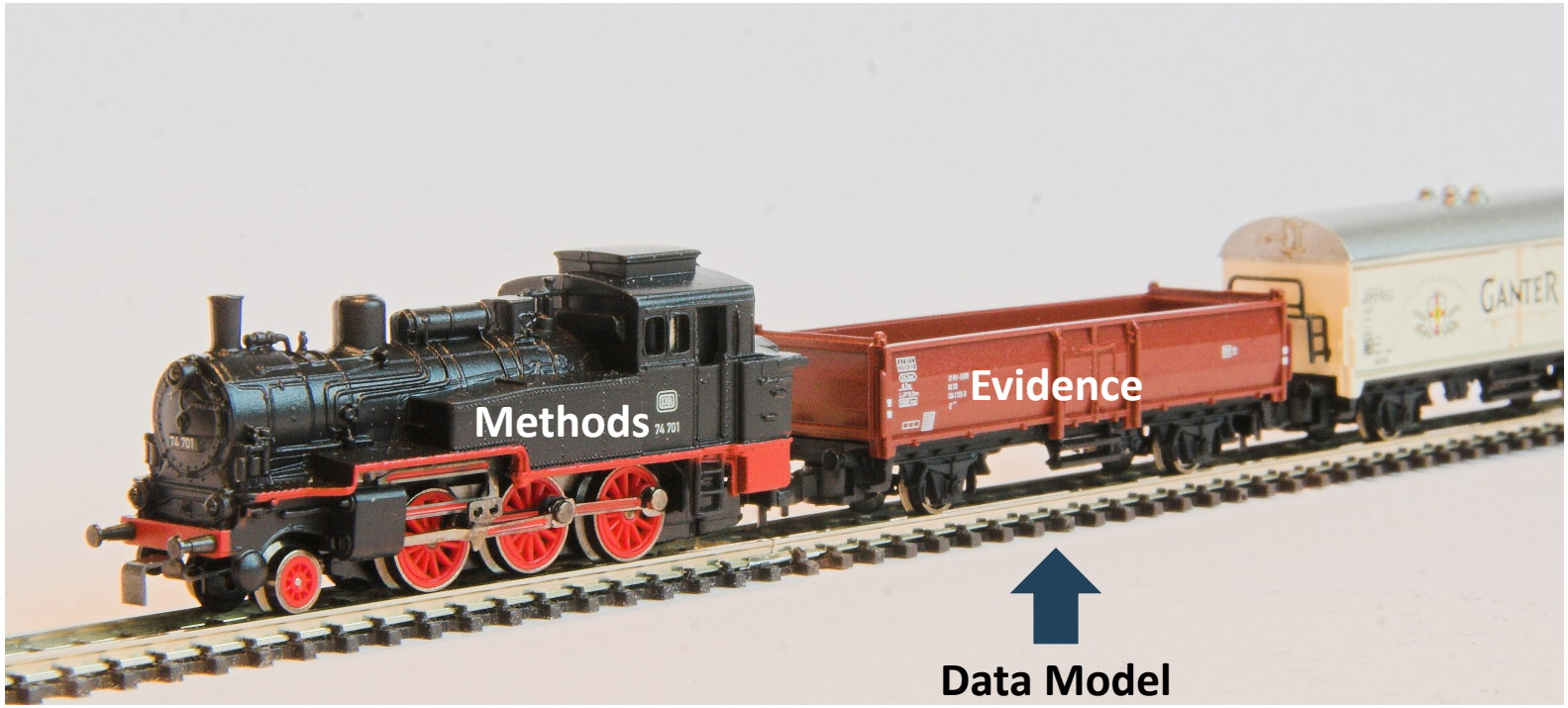
https://ohdsi.github.io/CommonDataModel/



https://athena.ohdsi.org



Why a Common Data Model



Why a Common Data Model

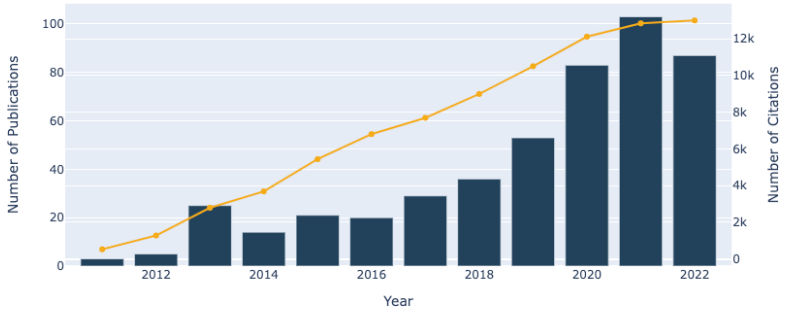
Why a Common Data Model

OHDSI Community Dashboard Dashboards

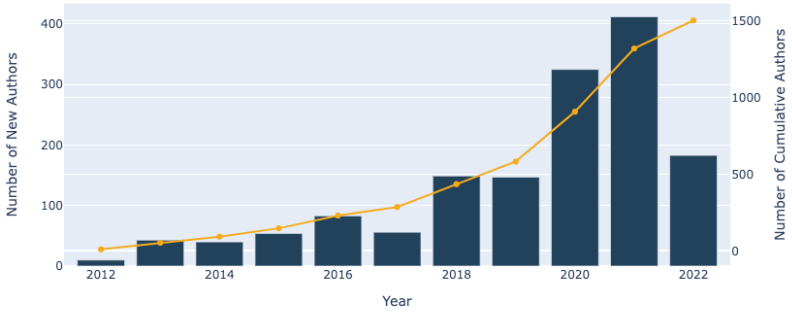
Publication Analysis

PubMed Publication Tracking highlights scholarship generated using the OMOP Common Data Model, OHDSI tools, or the OHDSI network. These publications represent scientific accomplishments across areas of data standards, methodological research, open-source development, and clinical applications. We provide the resource to search and browse the catalogue of OHDSI-related publications by date, author, title, journal, and SNOMED terms. We monitor the impact of our community using summary statistics (number of publications and citations), and the growth and diversity of our community with the number of distinct authors. Searches for new papers are performed daily, and citation counts are updated monthy.

OHDSI Publications & Cumulative Citations



New and Cumulative OHDSI Researchers

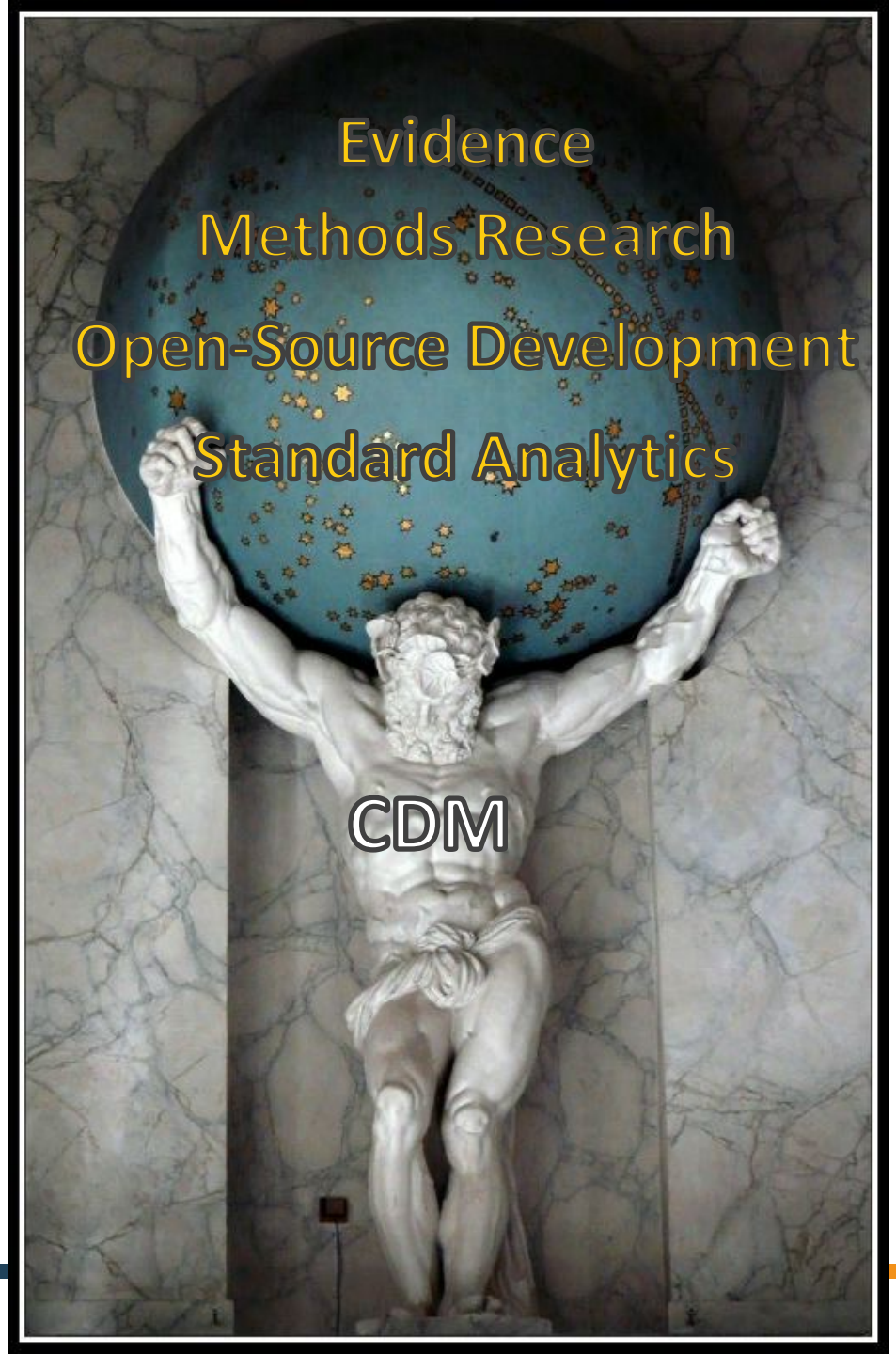


https://dash.ohdsi.org/publication_dashboard/

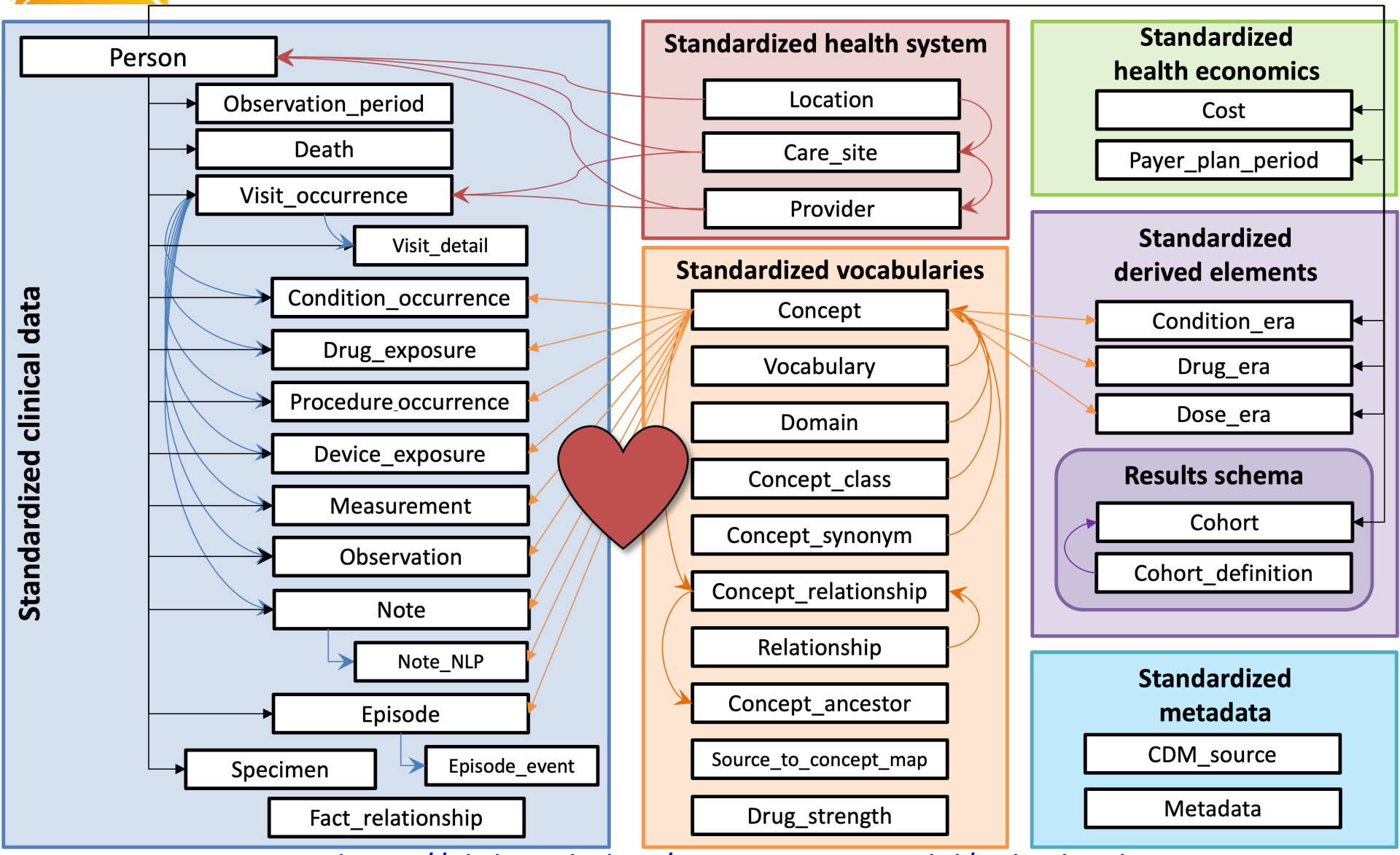
OMOP CDM

The OMOP CDM is a system of tables, vocabularies, and conventions that allow observational health data to be standardized. It is this standard approach that facilitates rapid innovation in the areas of open-source development, methods research, and evidence generation.

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

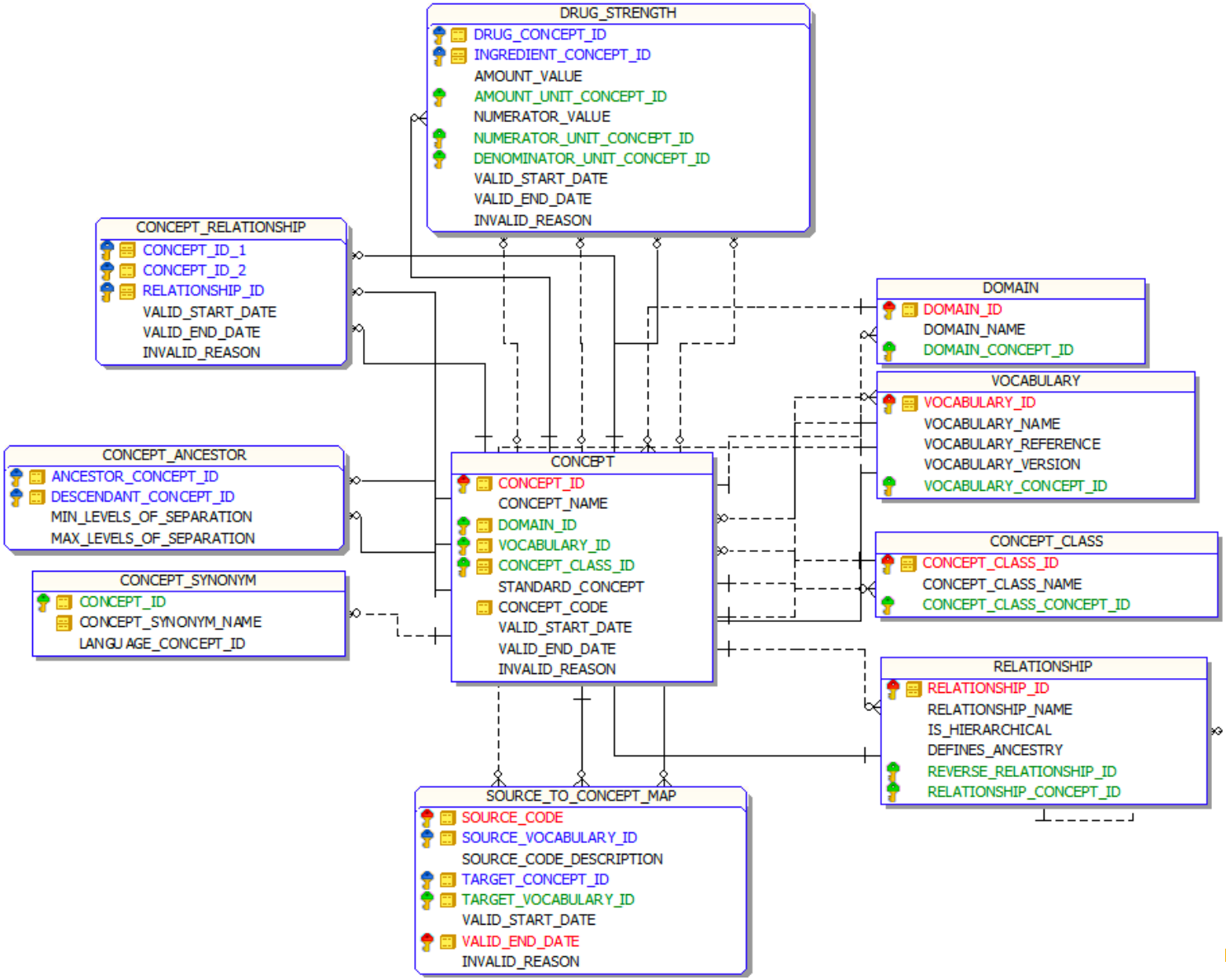

Evidence
Methods Research
Open-Source Development
Standard Analytics
CDM

OMOP CDM & Vocabulary

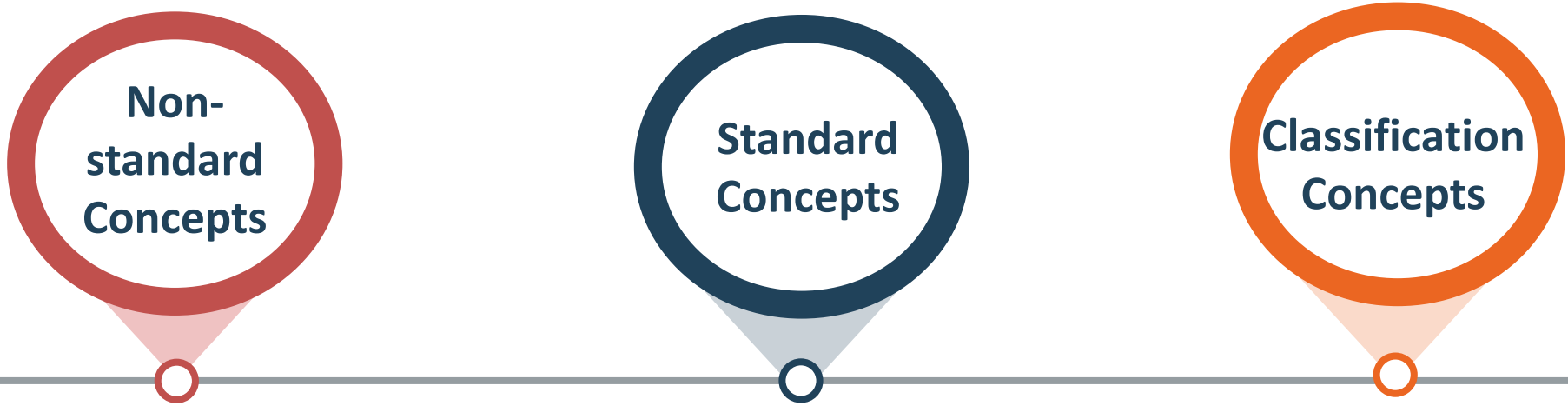


https://ohdsi.github.io/CommonDataModel/index.html

OMOP Vocabulary



Different Categories of Concepts



Function

Unique representation of a source code

Function

Used for standardized analytics and by OHDSI tools

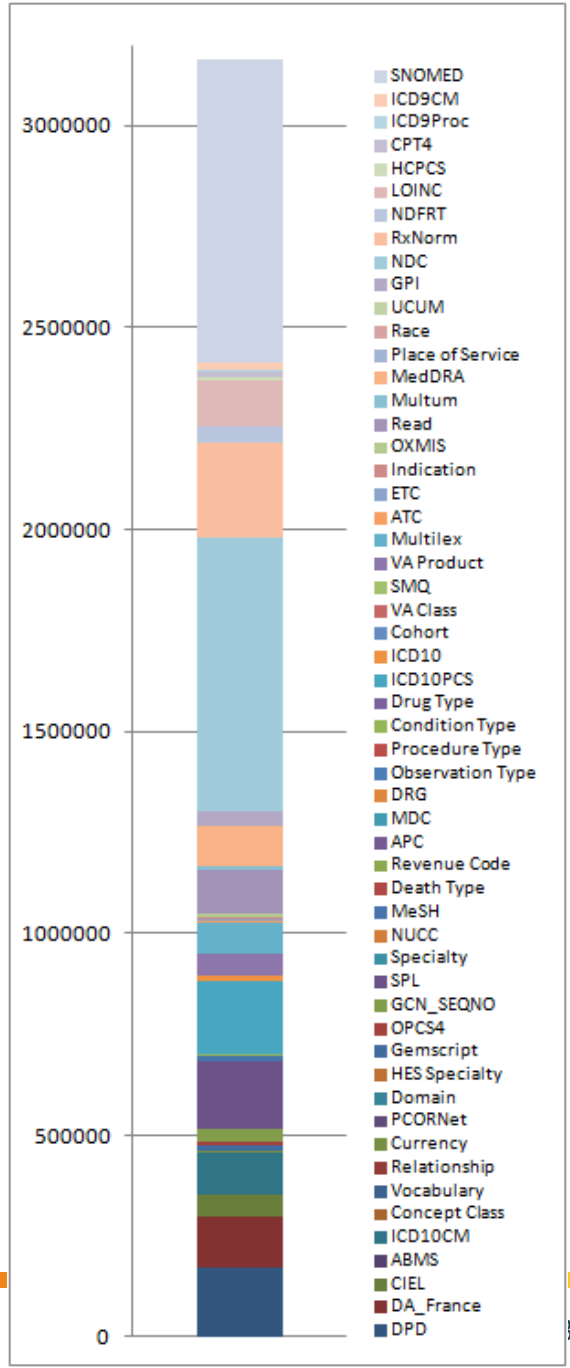
Function

Used to perform hierarchical queries

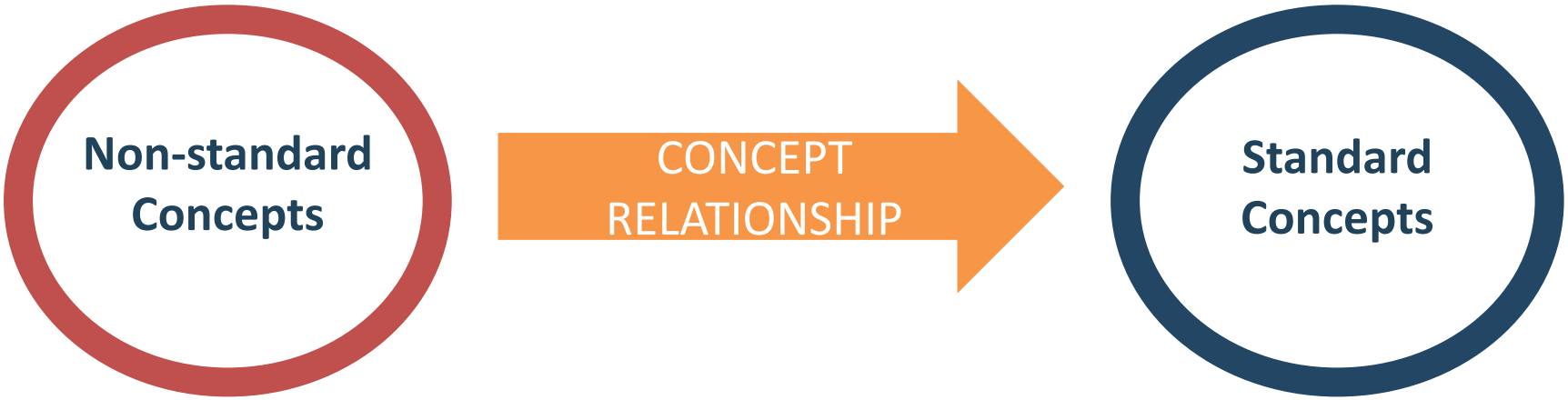
OMOP Vocabulary

- If your source data's codes are in the OMOP Vocab you can use it to translate to a standard

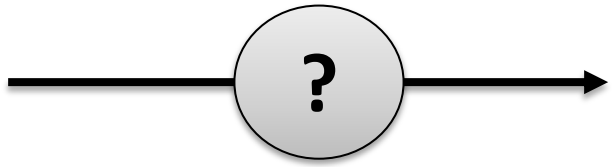
- For example:
  - ICD9 → SNOMED
  - NDC → RxNORM



Mapping to Standard Concepts



Standardizing Terminologies



What is standardized:

1. *TABLE*_CONCEPT_ID
   standard concept the source code maps to, **used for analysis**
2. *TABLE*_SOURCE_CONCEPT_ID
   concept representation of the source code, **helps maintain tie to raw data**
   a. *TABLE*_SOURCE_VALUE
      original source code as given in the source table, **helps to review data quality**

Ways to get a source code to standard code:

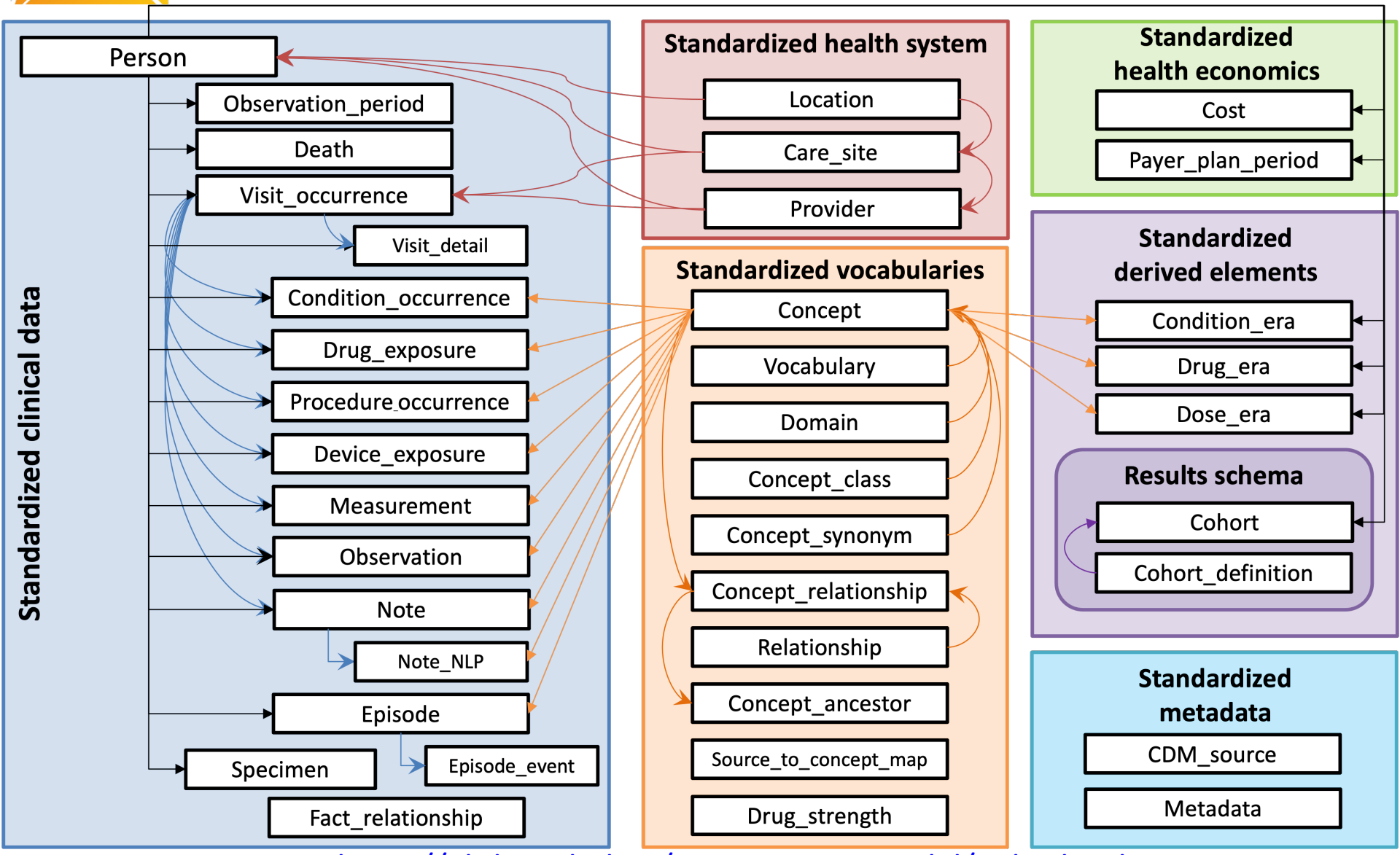
1. OMOP Vocabulary (Concept_Relationship)
2. USAGI

OMOP Vocab

- There are two standard queries to help us use the OMOP Vocabulary:
  - `SOURCE_TO_STANDARD.sql`
  - `SOURCE_TO_SOURCE.sql`

- https://ohdsi.github.io/CommonDataModel/sqlScripts.html

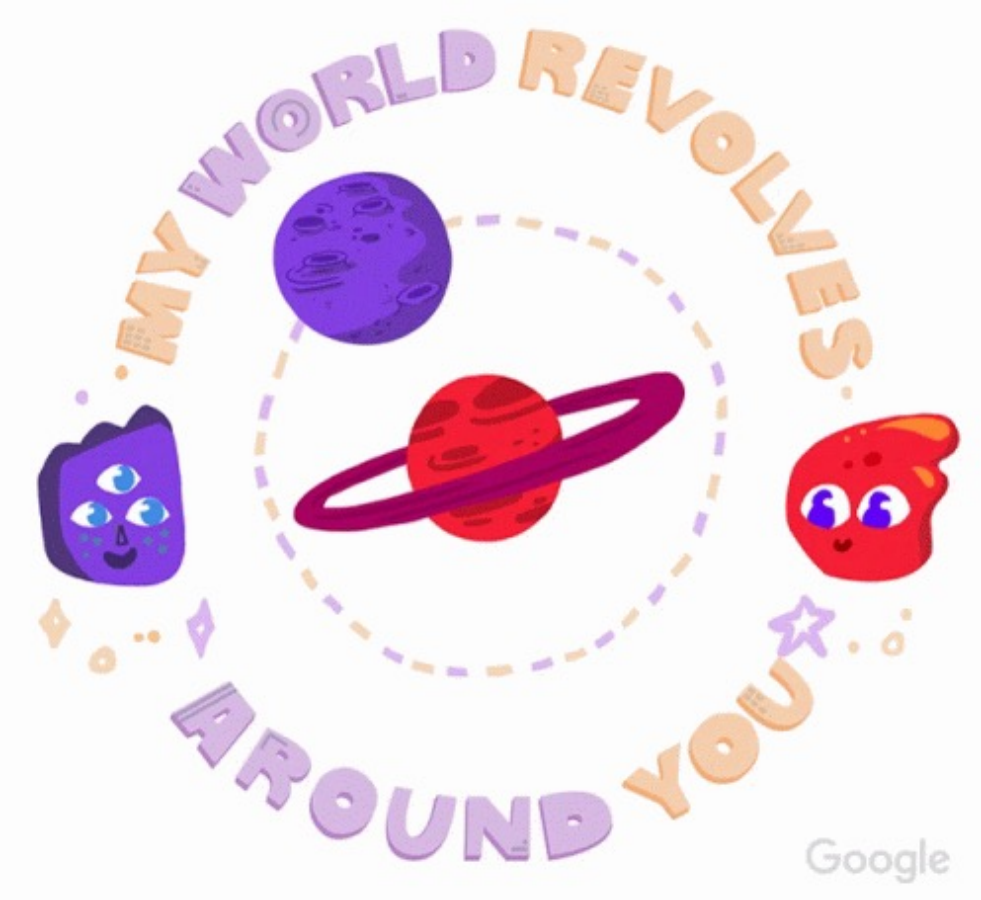
OMOP CDM



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

General Conventions

The OMOP CDM is a Person centric model



Table/Field conventions

PERSON

Table Description

This table serves as the central identity management for all Persons in the database. It contains records that uniquely identify each person or patient, and some demographic information.

User Guide

All records in this table are independent Persons.

ETL Conventions

All Persons in a database needs one record in this table, unless they fail data quality requirements specified in the ETL. Persons with no Events should have a record nonetheless. If more than one data source contributes Events to the database, Persons must be reconciled, if possible, across the sources to create one single record per Person. The content of the BIRTH_DATETIME must be equivalent to the content of BIRTH_DAY, BIRTH_MONTH and BIRTH_YEAR.

CDM Field	User Guide	ETL Conventions	Datatype	Required	Primary Key	Foreign Key	FK Table	FK Domain
person_id	It is assumed that every person with a different unique identifier is in fact a different person and should be treated independently.	Any person linkage that needs to occur to uniquely identify Persons ought to be done prior to writing this table. This identifier can be the original id from the source data provided if it is an integer, otherwise it can be an autogenerated number.	integer	Yes	Yes	No		

http://ohdsi.github.io/CommonDataModel/cdm54.html#PERSON

General conventions

- Required tables: person and observation_period
- Fields:
  - _id
  - _concept_id
  - _source_concept_id
  - _source_value
  - _type_concept_id
- Target concept domain determines target table

Fields

Variable names across all tables follow one convention:

Notation	Description
_SOURCE_VALUE	Verbatim information from the source data, typically used in ETL to map to CONCEPT_ID, and not to be used by any standard analytics. For example, CONDITION_SOURCE_VALUE = '787.02' was the ICD-9 code captured as a diagnosis from the administrative claim.
_ID	Unique identifiers for key entities, which can serve as foreign keys to establish relationships across entities. For example, PERSON_ID uniquely identifies each individual. VISIT_OCCURRENCE_ID uniquely identifies a PERSON encounter at a point of care.
_CONCEPT_ID	Foreign key into the Standardized Vocabularies (i.e. the standard_concept attribute for the corresponding term is true), which serves as the primary basis for all standardized analytics. For example, CONDITION_CONCEPT_ID = 31967 contains the reference value for the SNOMED concept of 'Nausea'
_SOURCE_CONCEPT_ID	Foreign key into the Standardized Vocabularies representing the concept and terminology used in the source data, when applicable. For example, CONDITION_SOURCE_CONCEPT_ID = 45431665 denotes the concept of 'Nausea' in the Read terminology; the analogous CONDITION_CONCEPT_ID might be 31967, since SNOMED-CT is the Standardized Vocabulary for most clinical diagnoses and findings.
_TYPE_CONCEPT_ID	Delineates the origin of the source information, standardized within the Standardized Vocabularies. For example, DRUG_TYPE_CONCEPT_ID can allow analysts to discriminate between 'Pharmacy dispensing' and 'Prescription written'

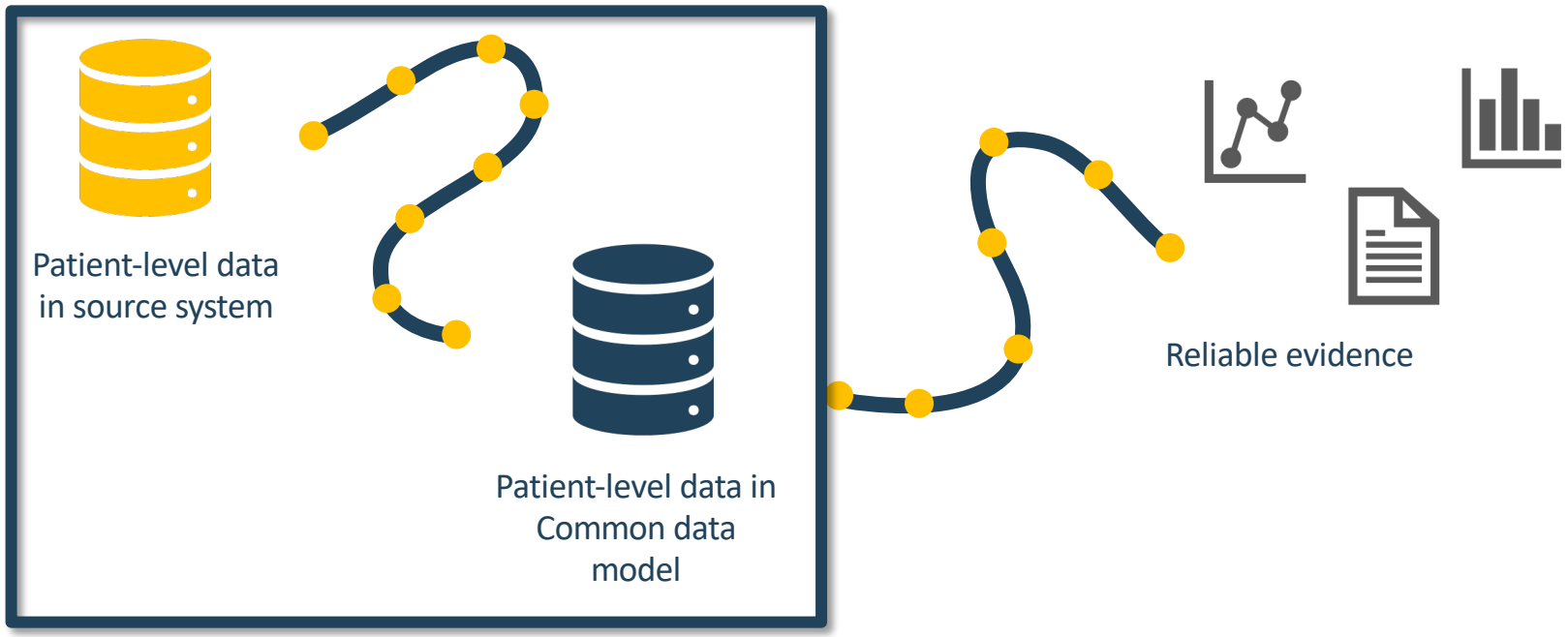
ETL Process and Tools

- Best Practices
- ETL Process
- ETL Tools
  - White Rabbit tool - review the output
  - Rabbit in a Hat tool - document the conceptual logic
  - Usagi - mapping custom source values

ETL

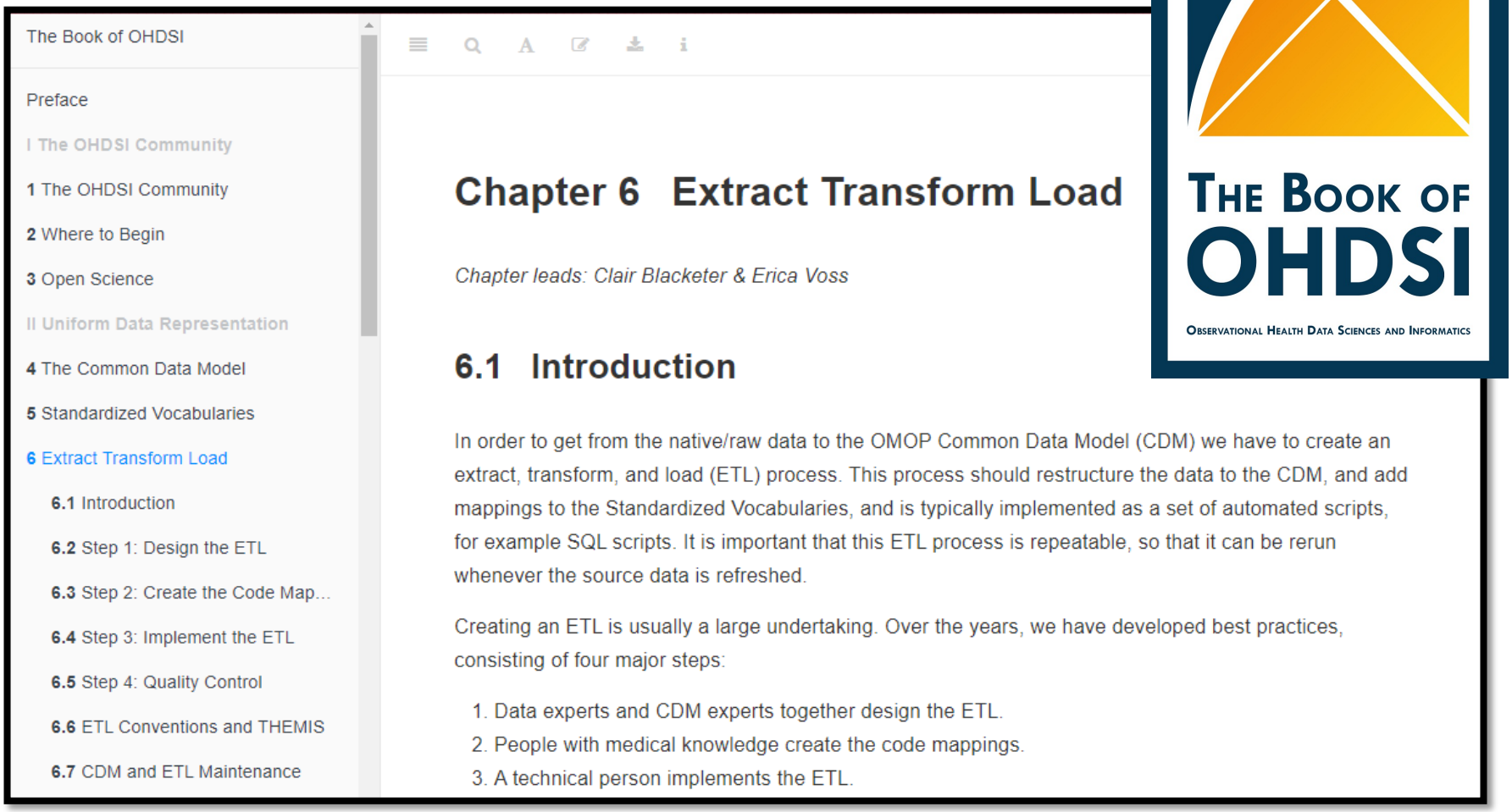
- Extract Transform Load

- In order to get from our native/raw data into the OMOP CDM we need to design and develop and ETL process



- Goal in ETLing is to standardize the format and terminology

ETL Process



https://ohdsi.github.io/TheBookOfOhdsi/ExtractTransformLoad.html

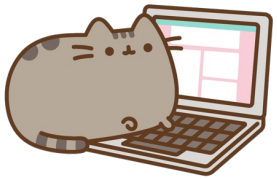
ETL Process

Data experts and CDM experts together design the ETL

People with medical knowledge create the code mappings

ETL Documentation

All are involved in quality control



A technical person implements the ETL

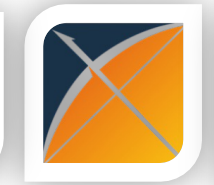
OHDSI Tools

White Rabbit

Rabbit In a Hat

Usagi

White Rabbit



ACHILLES

DQD

Rabbit In a Hat

OHDSI
OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS

Data experts and CDM experts together design the ETL

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ETL Documentation

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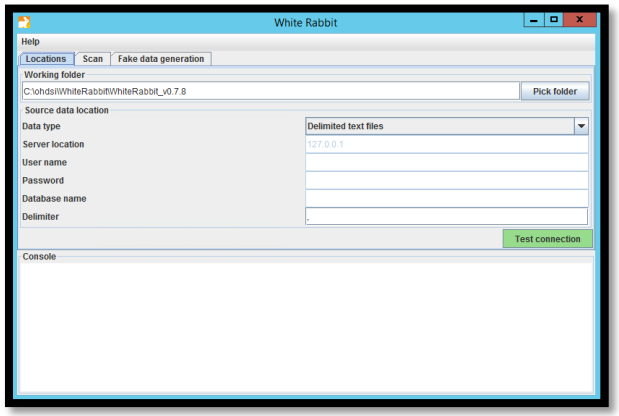
White Rabbit



- White Rabbit scans source data & creates a csv report on the source data
- The scan can be used to:
  - Learn about your source data
  - Help design the ETL
  - Used by Rabbit In a Hat

WR Output – ScanReport.xlsx

Table/Field Overview

Table	Field	Description	Type	Max length	N rows
pop	der_sex		character	1	16374539
pop	der_yob		double pre	6	16374539
pop	pat_id		character	64	16374539
pop	pat_hash_id		character	16	16374539
pop	pmtx_flag		numeric	1	16374539
pop	anon_ims_pat_id		character	11	16374539
pop	pat_region		character	2	16374539
pop	pat_state		character	2	16374539
pop	pat_zip3		character	3	16374539
pop	grp_indv_cd		character	1	16374539
pop	mh_cd		character	1	16374539
pop	enr_rel		character	2	16374539
pop	temp_col1		character	0	16374539
pop	temp_col2		character	0	16374539
pop	load_row_id		bigint	9	16374539
claims_diag_lk	person_source_valu		character	64	2992046684
claims_diag_lk	event_start_date		date	10	2992046684

Value counts

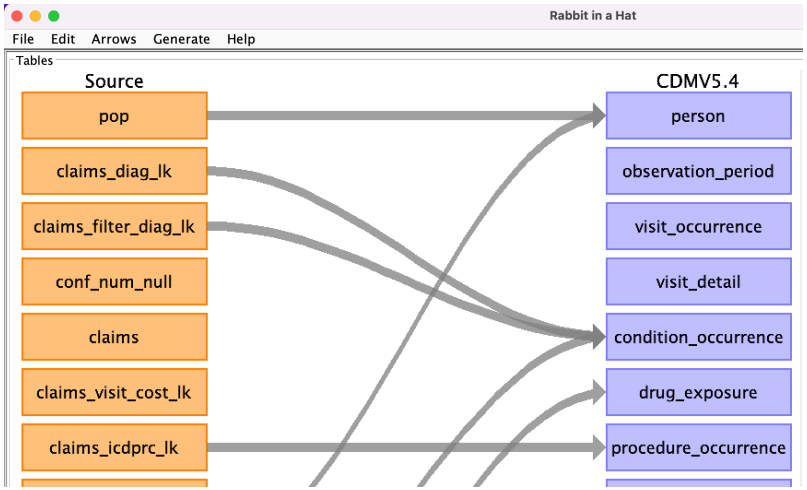
	A	B	C	D
1	der_sex	Frequency	der_yob	Frequency
2	F	50479	1991.0	2030
3	M	49514	1992.0	1970
4	U	7	1990.0	1947
5			1989.0	1908
6			1988.0	1873
7			1994.0	1872
8			1995.0	1806
9			1993.0	1805
10			1996.0	1716
11			1986.0	1676
12			1987.0	1643
13			1985.0	1633
14			1983.0	1588
15			1981.0	1581
16			1984.0	1576
17			1970.0	1555
18			1980.0	1553

pop | claims_diag_lk | claims

Rabbit in a Hat

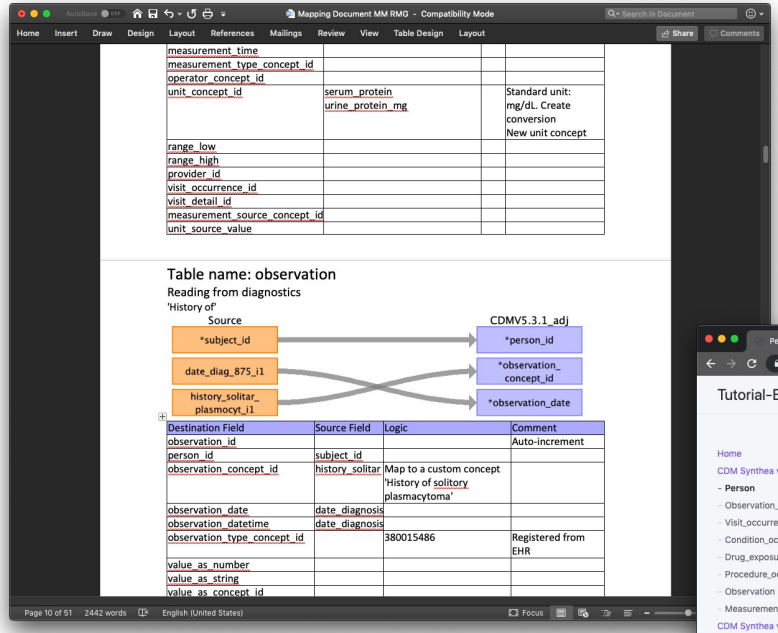
- Read and display a White Rabbit scan document

- Provides a graphical interface to allow a user to connect source data to CDM tables



RiaH - Output

Word document



measurement_time			
measurement_type_concept_id			
operator_concept_id			
unit_concept_id	serum_protein urine_protein_mg		Standard unit: mg/dL. Create conversion New unit concept
range_low			
range_high			
provider_id			
visit_occurrence_id			
visit_detail_id			
measurement_source_concept_id			
unit_source_value			

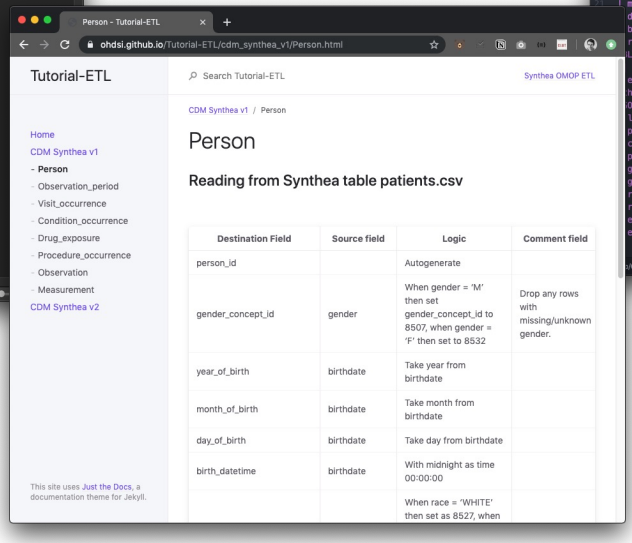
Table name: observation

Reading from diagnostics

'History of'

Destination Field	Source Field	Logic	Comment
observation_id			Auto-increment
person_id	subject_id		
observation_concept_id	history_solitar	Map to a custom concept 'History of solitory plasmacytoma'	
observation_date	date_diagnosis		
observation_datetime	date_diagnosis		
observation_type_concept_id		380015486	Registered from EHR
value_as_number			
value_as_string			
value_as_concept_id			

Html



Tutorial-ETL

Search Tutorial-ETL

Synthea OMOP ETL

Home
CDM Synthea v1
- Person
- Observation_period
- Visit_occurrence
- Condition_occurrence
- Drug_exposure
- Procedure_occurrence
- Observation
- Measurement
CDM Synthea v2

CDM Synthea v1 / Person

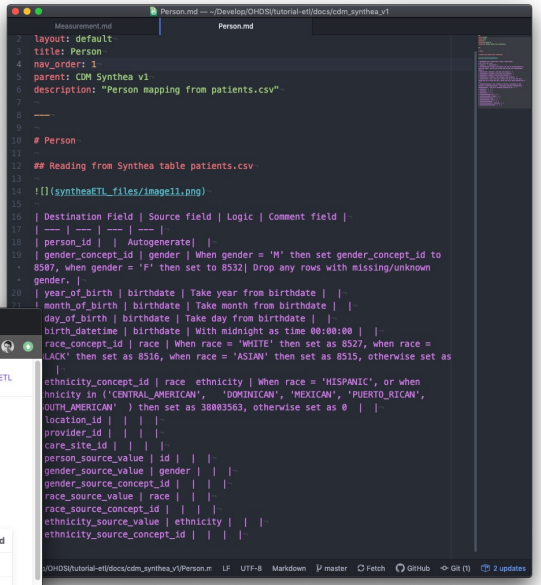
Person

Reading from Synthea table patients.csv

Destination Field	Source field	Logic	Comment field
person_id		Autogenerate	
gender_concept_id	gender	When gender = 'M' then set gender_concept_id to 8507, when gender = 'F' then set to 8532	Drop any rows with missing/unknown gender.
year_of_birth	birthdate	Take year from birthdate	
month_of_birth	birthdate	Take month from birthdate	
day_of_birth	birthdate	Take day from birthdate	
birth_datetime	birthdate	With midnight as time 00:00:00	
		When race = 'WHITE' then set as 8527, when	

This site uses Just the Docs, a documentation theme for Jekyll.

Markdown documents



```
layout: default
title: Person
nav_order: 1
parent: CDM Synthea v1
description: "Person mapping from patients.csv"

---

# Person

## Reading from Synthea table patients.csv

![](syntheaETL_files/image11.png)

| Destination Field | Source field | Logic | Comment field |
| --- | --- | --- | --- |
| person_id | | Autogenerate | |
| gender_concept_id | gender | When gender = 'M' then set gender_concept_id to 8507, when gender = 'F' then set to 8532 | Drop any rows with missing/unknown gender. |
| year_of_birth | birthdate | Take year from birthdate | |
| month_of_birth | birthdate | Take month from birthdate | |
| day_of_birth | birthdate | Take day from birthdate | |
| birth_datetime | birthdate | With midnight as time 00:00:00 | |
| race_concept_id | race | When race = 'WHITE' then set as 8527, when race = 'BLACK' then set as 8516, when race = 'ASIAN' then set as 8515, otherwise set as 0 | |
| ethnicity_concept_id | race | ethnicity | When race = 'HISPANIC', or when ethnicity in ('CENTRAL_AMERICAN', 'DOMINICAN', 'MEXICAN', 'PUERTO_RICAN', 'SOUTH_AMERICAN' ) then set as 38003563, otherwise set as 0 |
| location_id | | | |
| provider_id | | | |
| care_site_id | | | |
| person_source_value | id | | |
| gender_source_value | gender | | |
| gender_source_concept_id | | | |
| race_source_value | race | | |
| race_source_concept_id | | | |
| ethnicity_source_value | ethnicity | | |
| ethnicity_source_concept_id | | | |
```

OHDSI

OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS

Data experts and CDM experts together design the ETL

People with medical knowledge create the code mappings

ETL Documentation

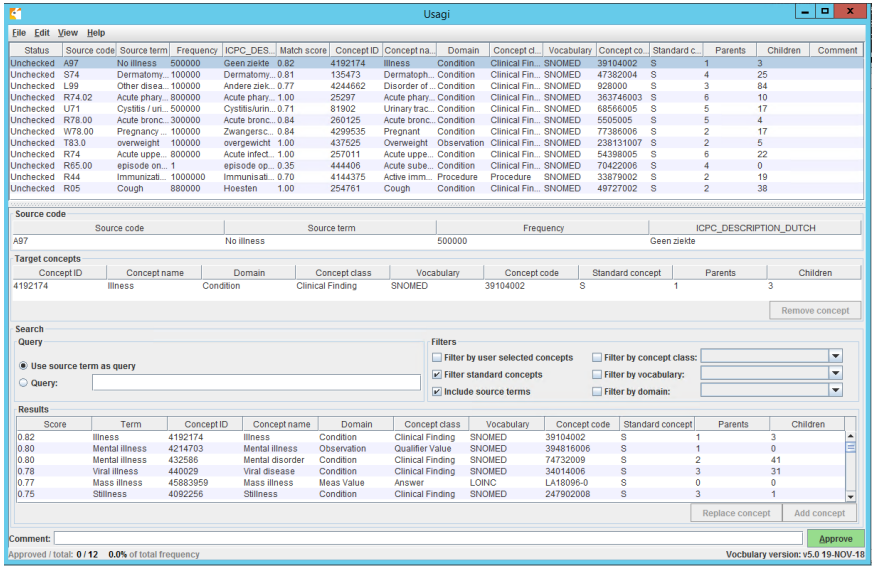
All are involved in quality control

A technical person implements the ETL

Usagi

- When the Vocabulary does not contain your source terms you will need to create a map to OMOP Vocabulary Concepts

- Usagi helps you to:
  - Find best matches, automatically and/or manually
  - Automatic matching based on text similarities (itf/df)
  - Create ‘source to concept map’



Overview - Steps

1. Get a copy of the Vocabulary from ATHENA
2. Download Usagi
3. **Have Usagi build an index on the Vocabulary**
4. Load your source codes and let Usagi process them
5. Review and update suggested mappings with someone who has medical knowledge
6. Export codes into the SOURCE_TO_CONCEPT_MAP

One-time setup

Data experts and CDM experts together design the ETL

People with medical knowledge create the code mappings

ETL Documentation

All are involved in quality control

A technical person implements the ETL

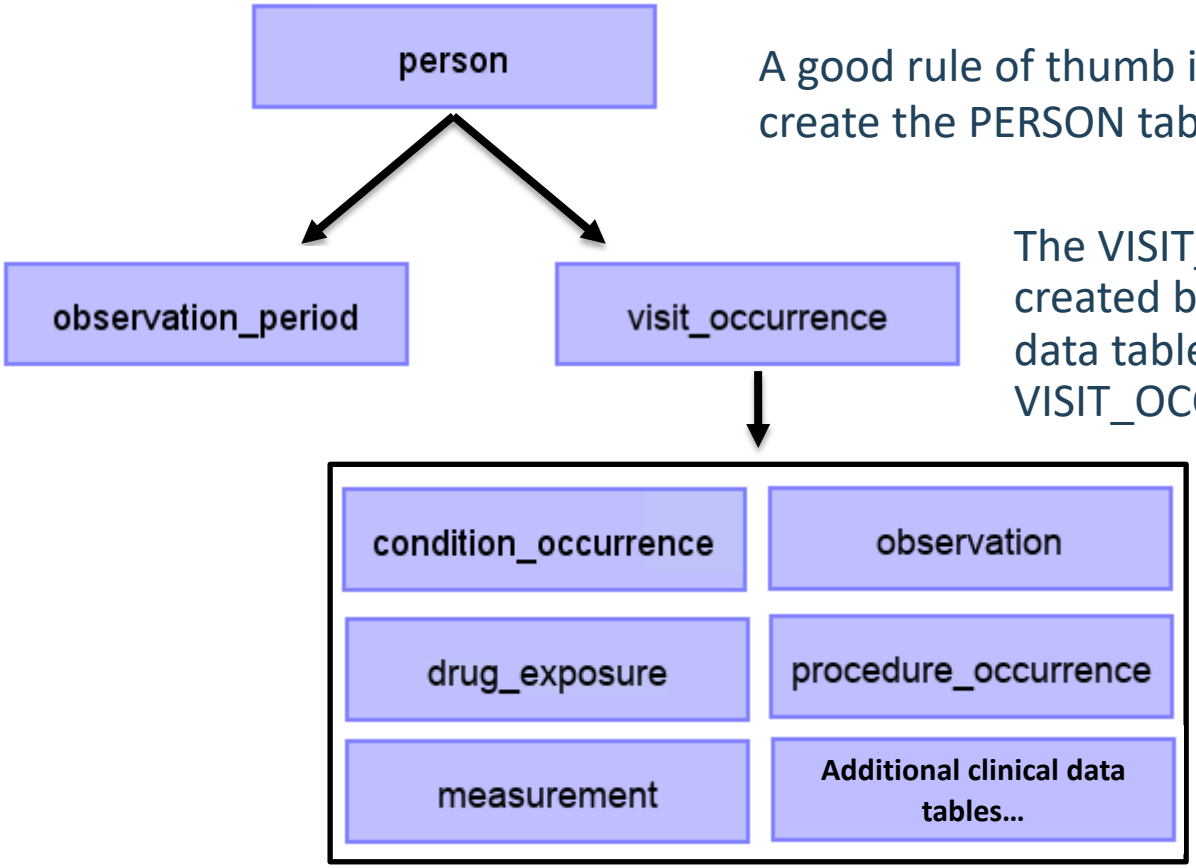
ETL Implementation

There are multiple tools available to implement your ETL

Your choice will largely depend on the size and complexity of the ETL design. And the tools available to you.

ETL Implementation

General Flow of Implementation



A good rule of thumb is to always create the PERSON table first

The VISIT_OCCURRENCE table must be created before the standardized clinical data tables as they all refer to the VISIT_OCCURRENCE_ID

Data experts and CDM experts together design the ETL

People with medical knowledge create the code mappings

ETL Documentation

All are involved in quality control

A technical person implements the ETL

Quality

What tools are available to check that the CDM logic was implemented correctly?

Rabbit-in-a-Hat Test Case Framework

Achilles

DataQualityDashboard (DQD)

Unit Test Cases

- Testing your CDM builder is important:
  - ETL is often complex, increasing the danger of making mistakes that go unnoticed
  - CDM can update
  - Source data structure/contents can change over time
- Rabbit-In-a-Hat can construct unit tests, or small pieces of code that can automatically check single aspects of the ETL design

Achilles

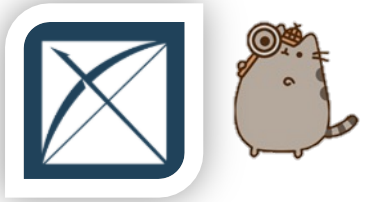
Achilles is a data characterization and quality tool available for download here:

https://github.com/OHDSI/Achilles

For an example of how it was run for some sample data, that R script is located here:

https://github.com/OHDSI/Tutorial-ETL/blob/master/materials/Achilles/achillesRun.R

DataQualityDashboard (DQD)



- Runs a prespecified set of data quality checks and thresholds on the CDM

OVERVIEW

METADATA

RESULTS

ABOUT

DATA QUALITY ASSESSMENT

SYNTHEA SYNTHETIC HEALTH DATABASE

Results generated at 2019-08-22 14:15:06 in 29 mins

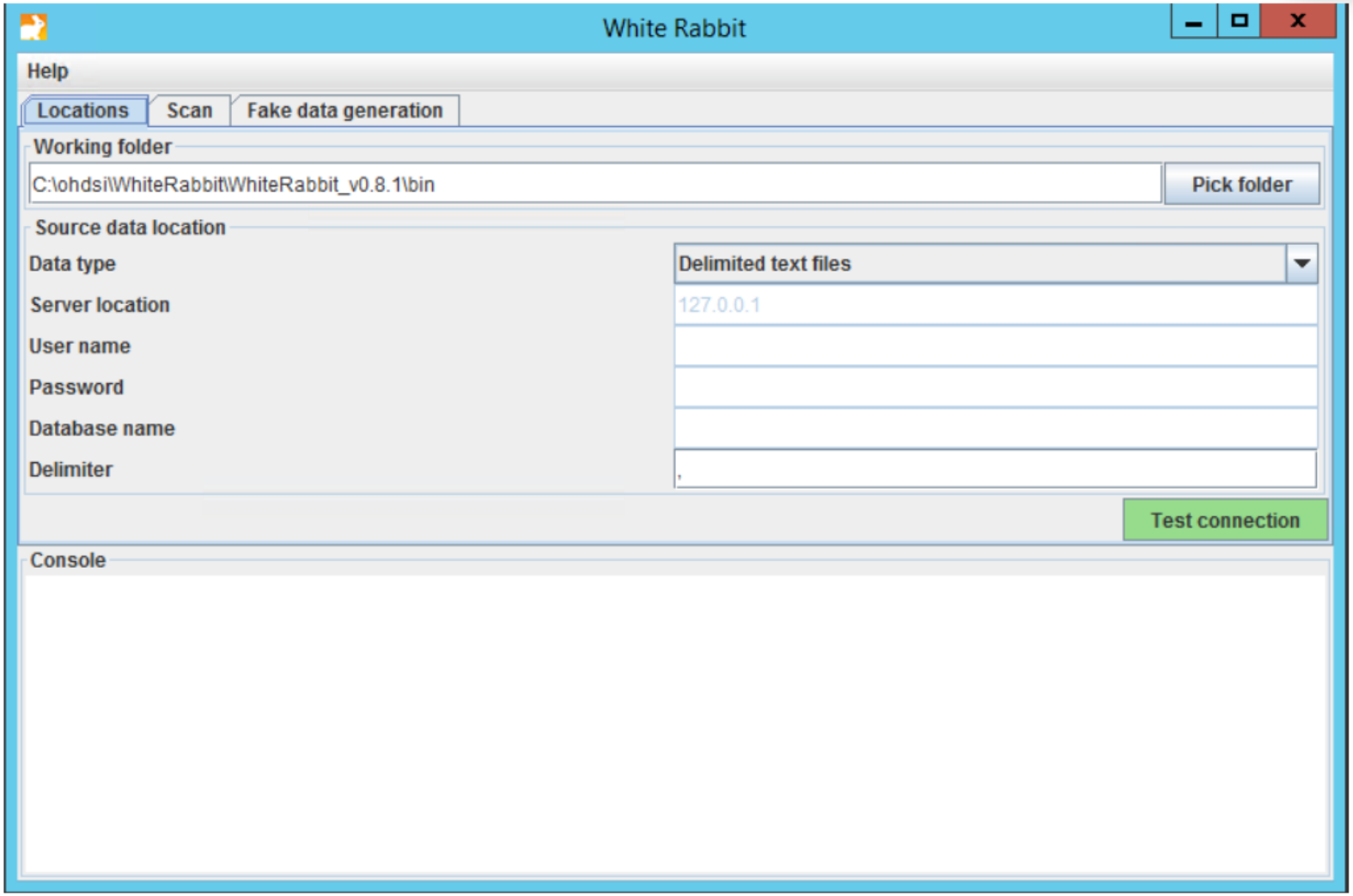
	Verification				Validation				Total			
	Pass	Fail	Total	% Pass	Pass	Fail	Total	% Pass	Pass	Fail	Total	% Pass
Plausibility	159	21	180	88%	283	0	283	100%	442	21	463	95%
Conformance	637	34	671	95%	104	0	104	100%	741	34	775	96%
Completeness	369	17	386	96%	5	10	15	33%	374	27	401	93%
Total	1165	72	1237	94%	392	10	402	98%	1557	82	1639	**95%**

10 Minute Energy Break

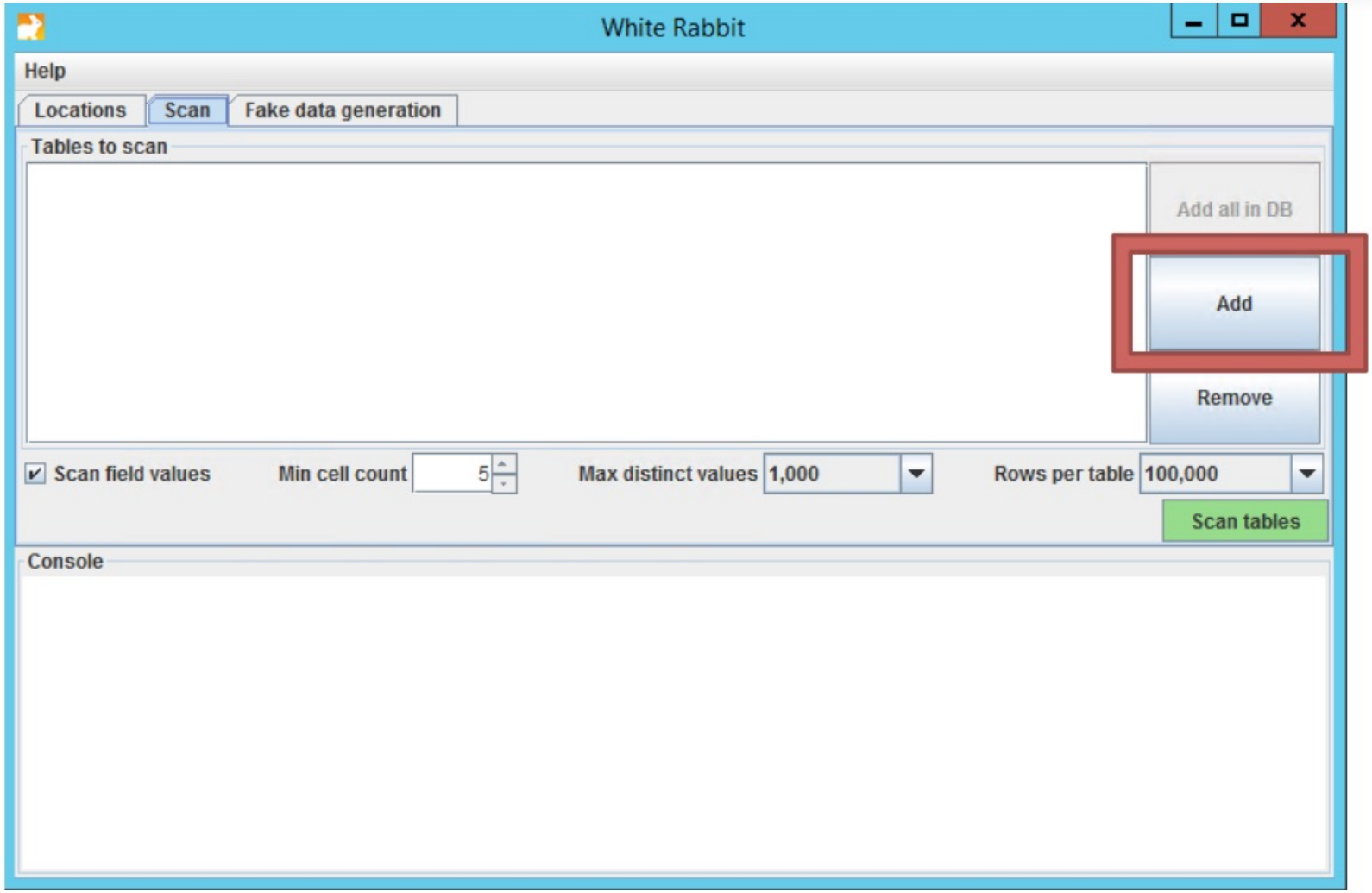
Upon your return, please open the ScanReport sent earlier this week. We will work through it in the next session

White Rabbit

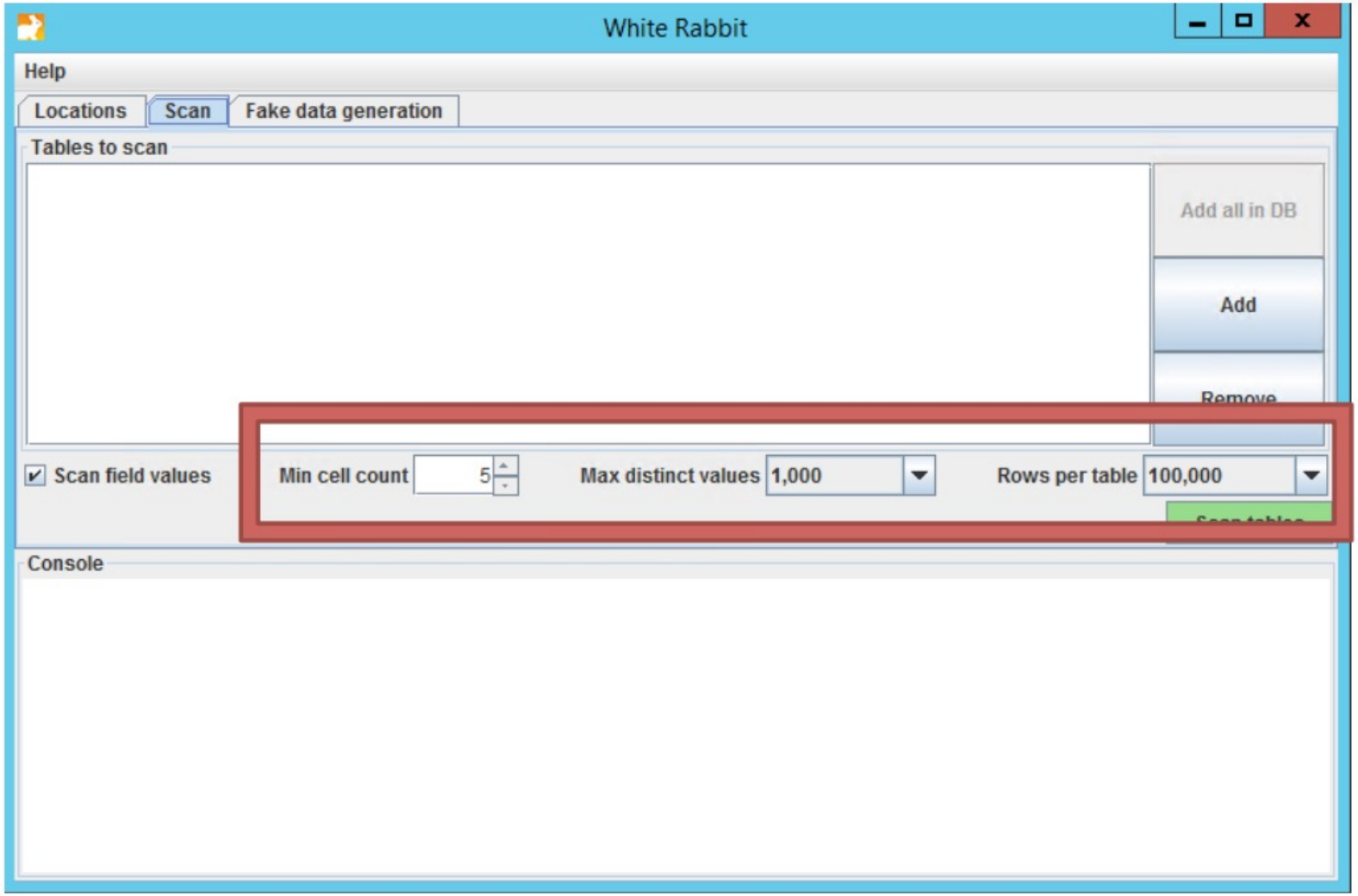
White Rabbit - Location



White Rabbit - Scan



White Rabbit - Scan



Let’s open the WR scan

Other ETL tools

- Excel Macros to Format White Rabbit Scan Report
  - located in OHDSI/sandbox
- Jackalope
- Perseus
- Epic User Web
  - Search “OMOP” as a keyword in the Epic forums

*This is not an exhaustive list. By Googling “OMOP ETL tools” you will find many papers and GitHub repositories devoted to helping you convert your health data to the CDM

OHDSI Community Resources

- GitHub
- forums.ohdsi.org
  - CDM builders
  - Implementers
  - Vocabulary
  - General - introduce yourself on the “Welcome to OHDSI” thread