

datajudge

Express and test specifications against data from database

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@kevkle

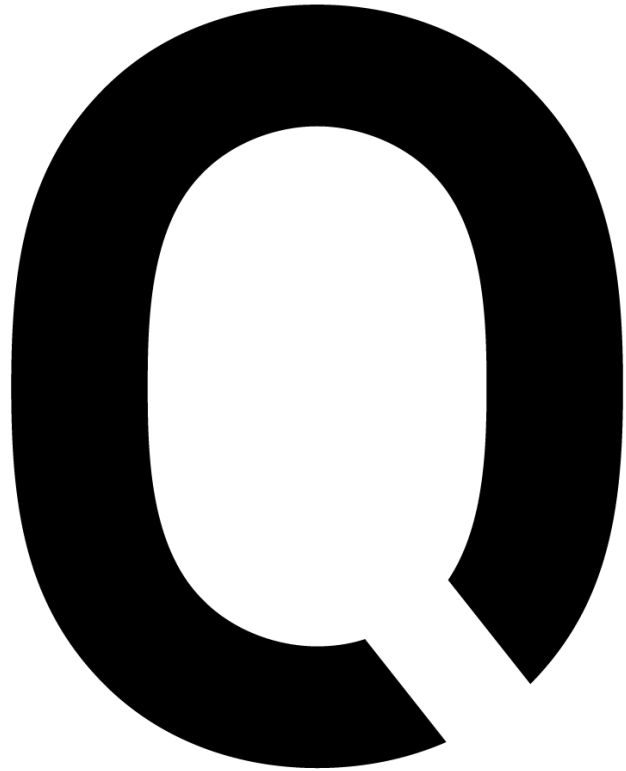


Agenda

1. Introduction
2. Case study: using `datajudge` to validate Twitch data
 - i. Setup
 - ii. Expressing expectations
 - iii. Testing expectations
3. General scenarios for comparing data sources

Me

- Computer Science at ETH Zurich and University of Washington
- Broad interest in Discrete Maths, Machine Learning and Software Engineering
- Currently Data Scientist/Machine Learning Engineer at QuantCo



quantco

- Data Science solutions
- Mostly fraud detection, pricing and demand forecasting
- join@quantco.com
- We contribute to OSS: `conda`, `conda-forge`, `mamba`, `pandas`, `glum`, `ONNX`, `jupyter-lab`

The data

channel	watch time	stream time	peak viewers	average viewers	followers	followers gained	
xQcOW	6196161750	215250	222720	27716	3246298	1734810	9
summit1g	6091677300	211845	310998	25610	5310163	1370184	8
Gaules	5644590915	515280	387315	10976	1767635	1023779	10
ESL_CSGO	3970318140	517740	300575	7714	3944850	703986	10
Tfue	3671000070	123660	285644	29602	8938903	2068424	7
...	

~1000 rows, 11 columns (7 numeric, 4 categorical)

- Assumptions
 - We rely on this data.
 - We receive monthly data deliveries.
 - Last month's delivery has been vetted manually.
- The task
 - We just received a new data delivery and want to use it for production purposes.



What could have happened between **v1** and **v2**?

- Benign growth
 - 'Just more data', same distribution, no surprises, no expectations violated
- Malignant growth
 - Data drift
 - Bug in data-generating code
 - Failure to communicate change in requirements/business logic

**NOT VALIDATING
YOUR DATA**



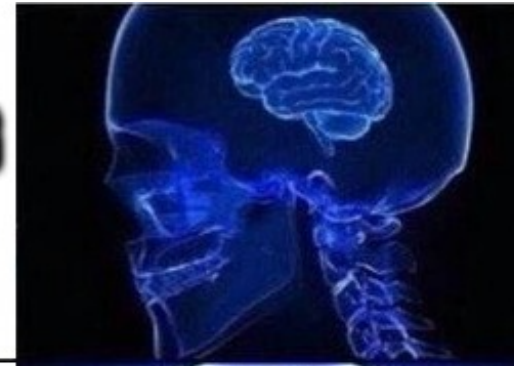
**NOT VALIDATING
YOUR DATA**



**VALIDATING
YOUR
DATA MANUALLY**



**NOT VALIDATING
YOUR DATA**



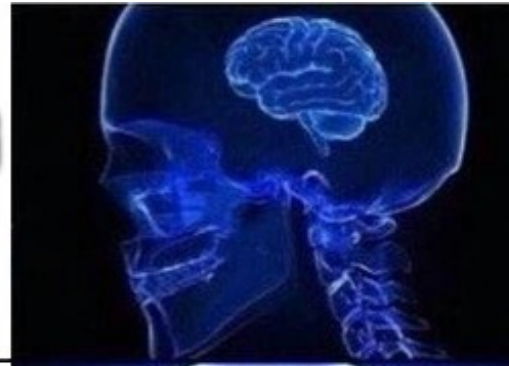
**VALIDATING
YOUR
DATA MANUALLY**



**VALIDATING
YOUR DATA
AUTOMATICALLY WITH
DOMAIN KNOWLEDGE**



**NOT VALIDATING
YOUR DATA**



**VALIDATING
YOUR
DATA MANUALLY**



**VALIDATING
YOUR DATA
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DOMAIN KNOWLEDGE**



**VALIDATING
YOUR DATA
AUTOMATICALLY WITH
REFERENCE DATA**



Using our domain knowledge to validate new data

- The `language` column should only contain values containing a non-empty sequence of the latin alphabet.

```
• from datajudge import WithinRequirement

# Defining a data source.
within_requirement = WithinRequirement.from_table(
    table_name="twitch_v2",
    schema_name=schema_name,
    db_name=db_name,
)

# Defining a constraint on the data source.
within_requirement.add_varchar_regex_constraint(
    column="language",
    regex="^[a-zA-Z]+$",
)
```

Using old data to validate the new data

- The `language` column should contain the same unique values we already encountered before.

- ```
from datajudge import BetweenRequirement

between_requirement_version = BetweenRequirement.from_tables(
 db_name1=db_name,
 db_name2=db_name,
 schema_name1=schema_name,
 schema_name2=schema_name,
 table_name1="twitch_v1",
 table_name2="twitch_v2",
)

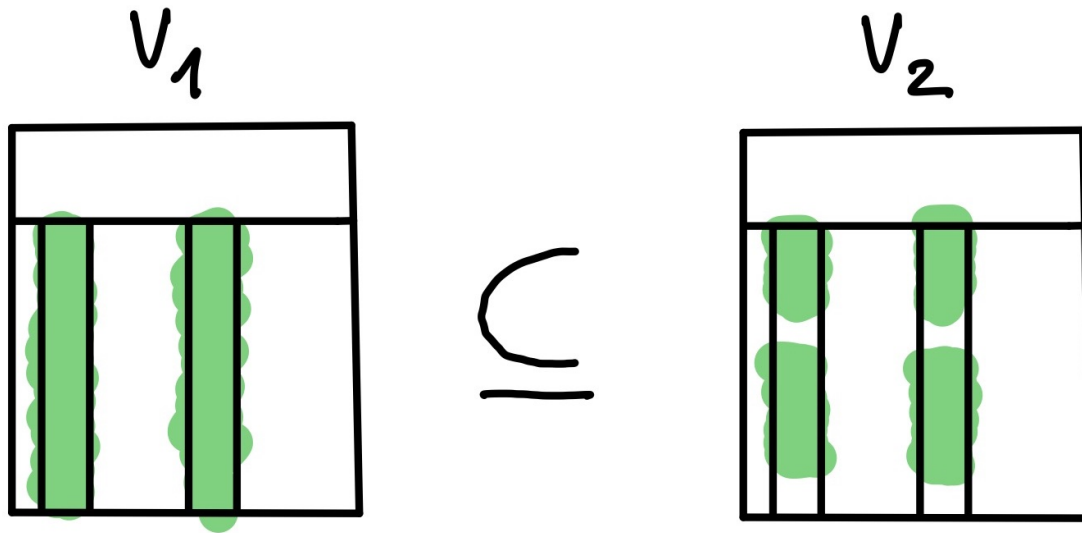
between_requirement_version.add_uniques_equality_constraint(
 columns1=["language"],
 columns2=["language"],
)
```

## Using old data to validate new data

- The column structure should be equal for both versions.
- ```
between_requirement_version.add_column_subset_constraint()  
between_requirement_version.add_column_superset_constraint()
```

Using old data to validate new data

- The static features of the rows in the old data should be present and unchanged in the new data.



Using old data to validate new data

- The static features of the rows in the old data should be present and unchanged in the new data.
- ```
columns = ["channel", "partnered", "mature"]
between_requirement_version.add_row_subset_constraint(
 columns1=columns,
 columns2=columns,
 constant_max_missing_fraction=.01,
)
```
- Note: `constant_max_missing_fraction` is a tolerance parameter.

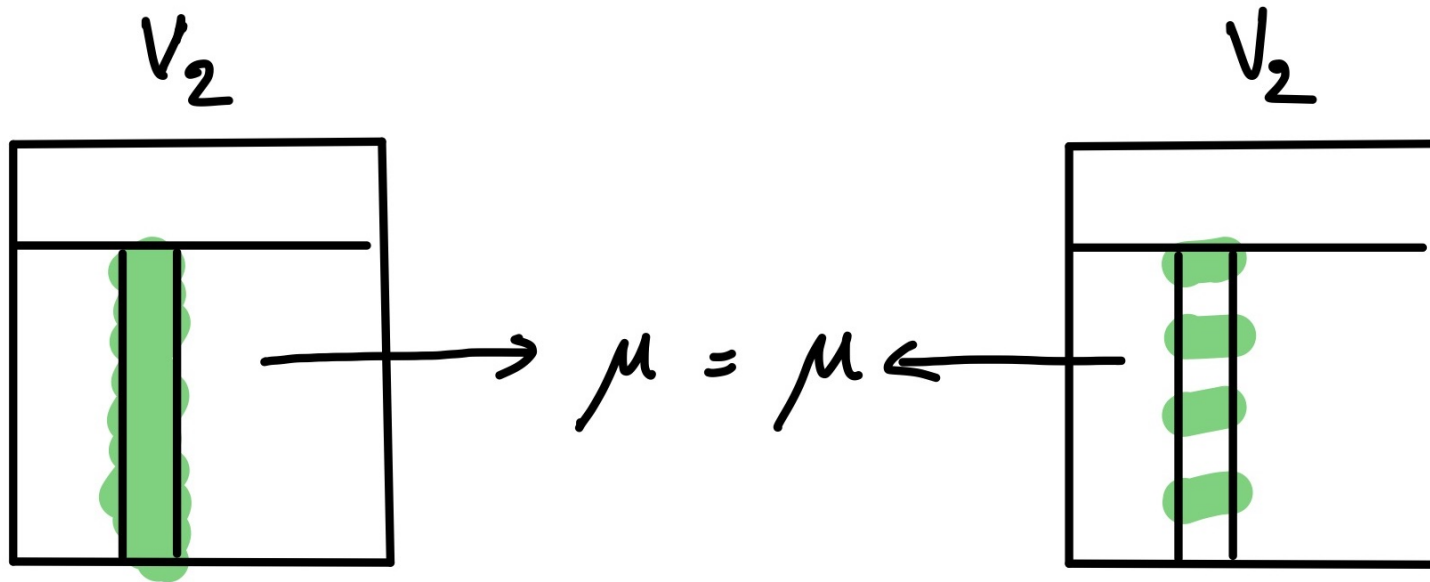
## Using new data to validate new data

- The distribution of `average_viewers` should follow the same underlying data generating process in both versions.
- 2-sample Kolmogorov Smirnov hypothesis test

```
between_requirement_version.add_ks_2sample_constraint(
 column1="average_viewers",
 column2="average_viewers",
 significance_level=0.05,
)
```

## Using new data to validate new data

- Mean of column `average_viewers` of mature channels shouldn't deviate too much from overall mean of that same column.



# Using new data to validate new data

- Mean of column `average_viewers` of mature channels shouldn't deviate too much from overall mean of that same column.

```
• between_requirement_columns = BetweenRequirement.from_tables(
 db_name1=db_name,
 db_name2=db_name,
 schema_name1=schema_name,
 schema_name2=schema_name,
 table_name1="twitch_v2",
 table_name2="twitch_v2",
)

between_requirement_columns.add_numeric_mean_constraint(
 column1="average_viewers",
 column2="average_viewers",
 condition1=None,
 condition2=Condition(raw_string="mature IS TRUE"),
 max_absolute_deviation=0.1,
)
```

## Execution of tests

- All of the previous code simply goes into a Python file.
- Add few lines of boilerplate code:

```
requirements = [
 within_requirement,
 between_requirement_version,
 between_requirement_columns,
]
test_func = `collect_data_tests(requirements)`
```

- Execute with `pytest`: `$ pytest specification.py`

# AssertionError

```
_____ test_func[UniquesEquality::public.twitch_v1 | public.twitch_v2] _____

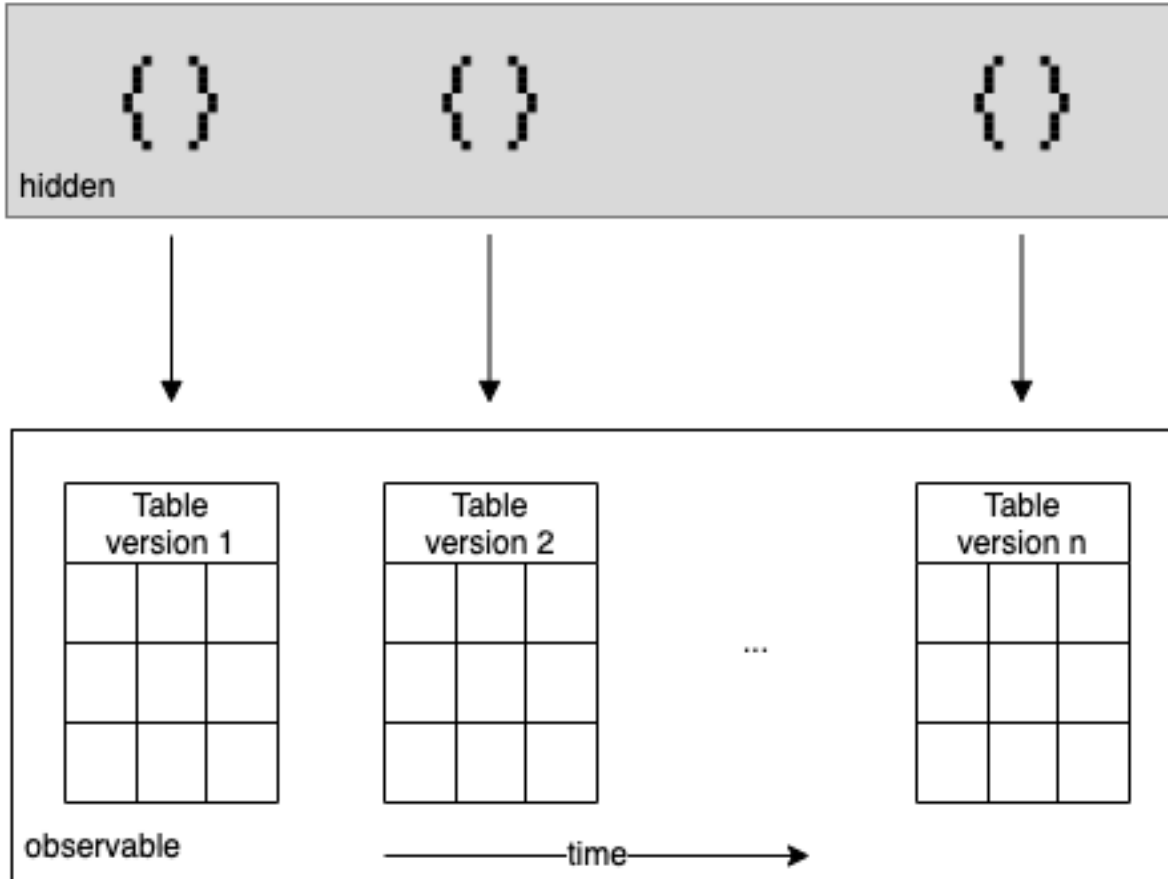
constraint = <datajudge.constraints.uniques.UniquesEquality object at 0x108087e20>
datajudge_engine = Engine(postgresql://datajudge:***@localhost:5432/datajudge)

@pytest.mark.parametrize(
 "constraint", all_constraints, ids=Constraint.get_description
)
def test_constraint(constraint, datajudge_engine):
 test_result = constraint.test(datajudge_engine)
 > assert test_result.outcome, test_result.failure_message
E AssertionError: tempdb.public.twitch_v1's column(s) 'language' doesn't have
 the element(s) {'Sw3d1zh'} when compared with the reference values.

/usr/local/Caskroom/.../lib/python3.10/site-packages/datajudge/pytest_integration.py:25:
AssertionError
```

```
===== short test summary info =====
FAILED twitch_specification.py::test_func[VarCharRegex::tempdb.public.twitch_v2] - AssertionError...
FAILED twitch_specification.py::test_func[KolmogorovSmirnov2Sample::public.twitch_v1 | public.twitch_v2]
FAILED twitch_specification.py::test_func[UniquesEquality::public.twitch_v1 | public.twitch_v2]
FAILED twitch_specification.py::test_func[NumericMean::public.twitch_v2 | public.twitch_v2] - Ass...
===== 4 failed, 4 passed in 1.80s =====
```

## Comparisons between data sources: Across time

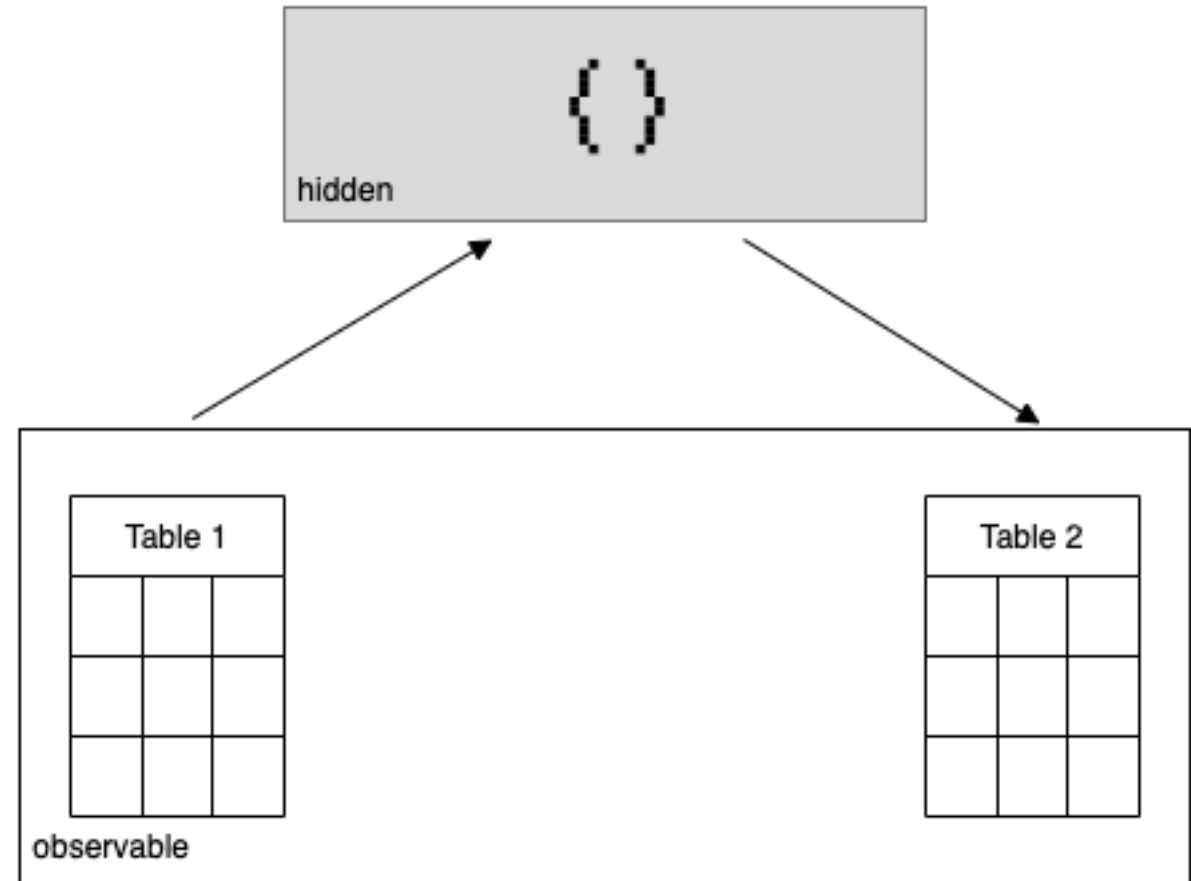


- Tables with equal structure and semantics.
- Tables from different points in time.
- Compare content with respect to expected change.
- Relevant use case: Obfuscated data-generating code between pipeline runs.



# Comparisons between data sources: Across space

- Tables of different structure.
- Tables could have an input-output relationship.
- Compare tables with respect to invariants.
  - E.g. Min in summary stats table should be equal to min in unit table.
- Relevant use case: Obfuscated data-generating code between steps of a pipeline.



## **datajudge**: Good to know

- Only relational databases are supported.
  - Currently test against Postgres, Snowflake and Mssql.
  - Yet, not only tables serve as data sources. A data source can also be the result of a SQL query.
- Heavy lifting happens in database, only test results are fetched to memory.
  - Can be very advantageous in terms of memory consumption and runtime.
- **datajudge** generates SQL queries from high-level API.
  - It relies on the SQLAlchemy Language Expression API to be dialect-agnostic.
  - Generated queries are logged and can be used for data debugging.
- Many more constraints exist.
  - E.g.: constraints for date columns, useful to validate historization of database

## One more thing

- `datajudge` has been collaborative work and grew as a side project.
- Please share thoughts/ideas/suggestions!
- <https://github.com/QuantCo/datajudge>

**Questions?**

# How do we use datajudge at QuantCo?

- Generate html test reports with a pytest plugin.
  - `pytest specification.py --html=report.html`
  - Eases collaboration and archiving.
- Parametrize data sources.
  - `pytest specification.py --new_db new_db --old_db old_db`
- Subselect tests
  - `pytest specification.py -k varchar_constraint`
- Integration in CI.

## Why not just use database constraints?

- Not available across dialects/dbms.
- No error tolerance.
- No conditioning.
- No/hardly any comparisons between data sources.
- Only operate on a row-level.
  - E.g. constraining the mean of a column is not possible.
- Different workflow: pre-transaction vs. post-transaction.

## Why not use **Great Expectations** ?

|                          | <b>datajudge</b>      | <b>Great Expectations</b>        |
|--------------------------|-----------------------|----------------------------------|
| Comparisons between data | First-class citizen   | Tricky :/                        |
| Data sources             | Relational databases  | Databases, files, in-memory data |
| Adoption                 | Fast startup time     | Complex ecosystem                |
| Objective                | Testing (/monitoring) | Exploration, monitoring, testing |
| SQL logic                | By framework          | By user/by framework             |