

# Quality Assessment

## - Data Quality

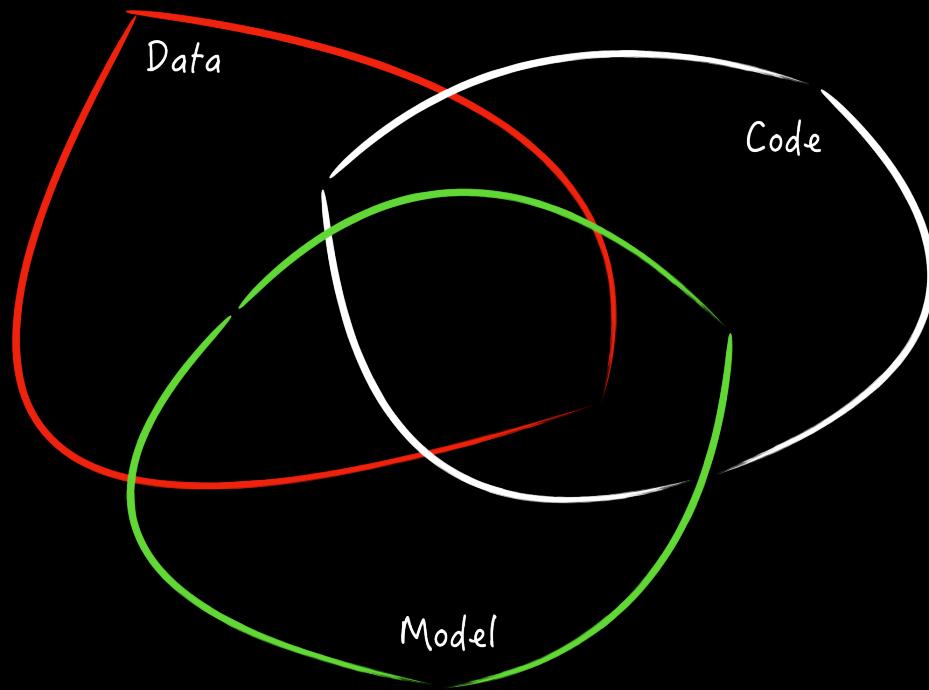
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SOCS McGill University

# Software Quality Management

Quality  
Standard

Review and  
Inspections

Quality Management Process



# Data Quality

- What makes “good” data for machine learning?

Contains relevant features

Reflect real interactions

Good coverage

Few or no biases

Large enough

# Data Quality

Dimensions	Elements
1) Availability	1) Accessibility
2) Usability	2) Timeliness
3) Reliability	1) Credibility
	1) Accuracy
	2) Consistency
	3) Integrity
	4) Completeness
4) Relevance	1) Fitness
5) Presentation Quality	1) Readability

Cai, L. and Zhu, Y., 2015. The Challenges of Data Quality and Data Quality Assessment in the Big Data Era. *Data Science Journal*, 14, p.2. DOI: <http://doi.org/10.5334/dsj-2015-002>

# Data Quality

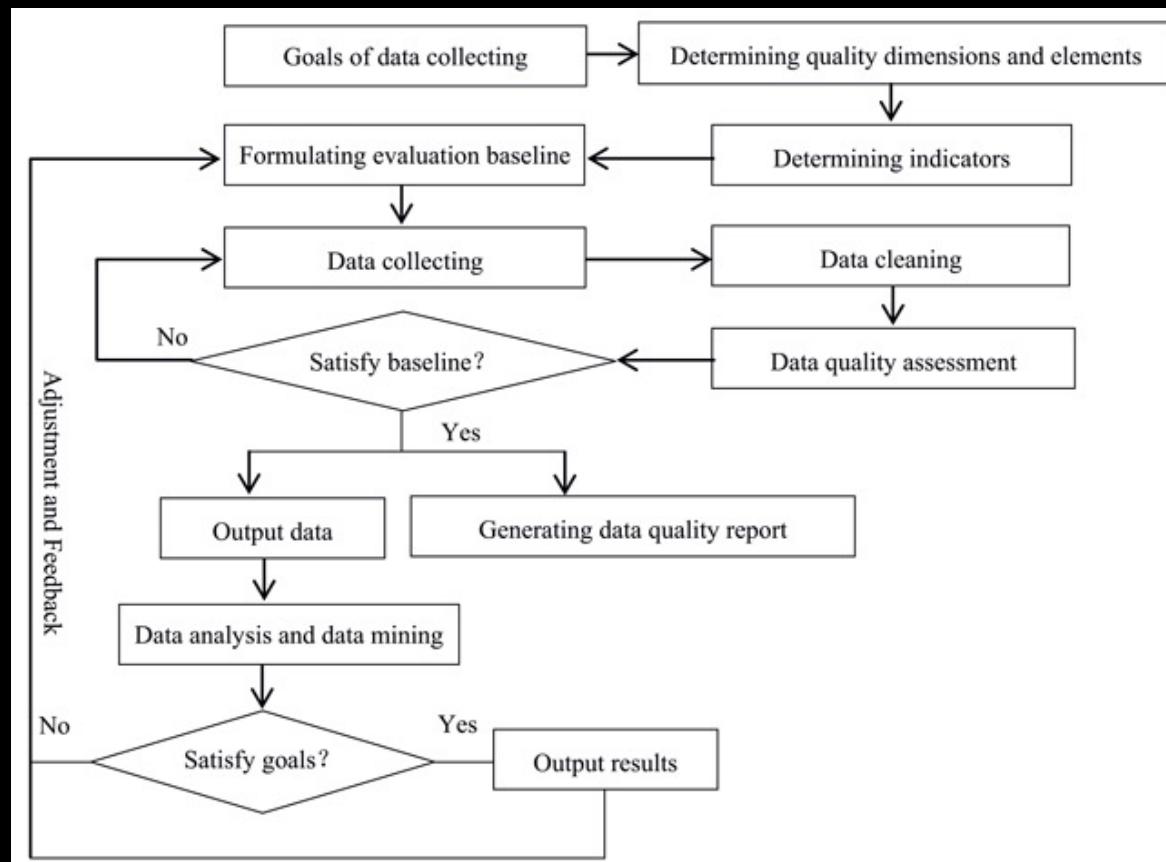
Dimensions	Elements
1) Availability	1) Accessibility
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	1) Accuracy
	2) Consistency
	3) Integrity
4) Relevance	4) Completeness
5) Presentation Quality	1) Fitness
	1) Readability

e.g. indicators of accessibility:

- Whether a data access interface is provided
- Data can be easily made public or easy to purchase

Cai, L. and Zhu, Y., 2015. The Challenges of Data Quality and Data Quality Assessment in the Big Data Era. *Data Science Journal*, 14, p.2. DOI: <http://doi.org/10.5334/dsj-2015-002>

# Data Quality Assessment Process



Cai, L. and Zhu, Y., 2015. The Challenges of Data Quality and Data Quality Assessment in the Big Data Era. *Data Science Journal*, 14, p.2. DOI: <http://doi.org/10.5334/dsj-2015-002>

# Datasheet

# Review Dataset documentation

<b>Motivation for Dataset Creation</b>
Why was the dataset created? (e.g., were there specific tasks in mind, or a specific gap that needed to be filled?)
What (other) tasks could the dataset be used for? Are there obvious tasks for which it should not be used?
Has the dataset been used for any tasks already? If so, where are the results so others can compare (e.g., links to published papers)?
Who funded the creation of the dataset? If there is an associated grant, provide the grant number.
Any other comments?

<b>Data Collection Process</b>
How was the data collected? (e.g., hardware apparatus/sensor, manual human curation, software program, software interface/API; how were these constructs/measures/methods validated?)
Who was involved in the data collection process? (e.g., students, crowdworkers) How were they compensated? (e.g., how much were crowdworkers paid?)
Over what time-frame was the data collected? Does the collection time-frame match the creation time-frame?
How was the data associated with each instance acquired? Was the data directly observable (e.g., raw text, movie ratings), reported by subjects (e.g., survey responses), or indirectly inferred/derived from other data (e.g., part of speech tags; model-based guesses for age or language)? If the latter two, were they validated/verified and if so how?
Does the dataset contain all possible instances? Or is it, for instance, a sample (not necessarily random) from a larger set of instances?
If the dataset is a sample, then what is the population? What was the sampling strategy (e.g., deterministic, probabilistic with specific sampling probabilities)? Is the sample representative of the larger set (e.g., geographic coverage)? If not, why not (e.g., to cover a more diverse range of instances)? How does this affect possible uses?
Is there information missing from the dataset and why? (this does not include intentionally dropped instances; it might include, e.g., redacted text, withheld documents) Is this data missing because it was unavailable?
Are there any known errors, sources of noise, or redundancies in the data?
Any other comments?

<b>Data Preprocessing</b>
What preprocessing/cleaning was done? (e.g., discretization or bucketing, tokenization, part-of-speech tagging, SIFT feature extraction, removal of instances, processing of missing values, etc.)
Was the "raw" data saved in addition to the pre-processed/cleaned data? (e.g., to support unanticipated future uses)
Is the preprocessing software available?
Does this dataset collection/processing procedure achieve the motivation for creating the dataset stated in the first section of this datasheet?
What are the requirements, implementation details, and limitations of instances? Any other comments?
Are relationships between instances made explicit in the data (e.g., social network links, user/movie ratings, etc.)?
How many instances of each type are there?
What data does each instance consist of? "Raw" data (e.g., unprocessed text or images)? Features/attributes? Is there a label/target associated with instances? If the instances are related to people, are subpopulations identified (e.g., by age, gender, etc.) and what is their distribution?
Is everything included or does the data rely on external resources? (e.g., websites, tweets, datasets) If external resources, a) are there guarantees that they will exist, and remain constant, over time; b) is there an official archival version. Are there licenses, fees or rights associated with any of the data?
Are there recommended data splits or evaluation measures? (e.g., training, development, testing; accuracy/AUC)
What experiments were initially run on this dataset? Have a summary of those results and, if available, provide the link to a paper with more information here.
Any other comments?

<b>Dataset Distribution</b>
How is the dataset distributed? (e.g., website, API, etc.; does the data have a DOI; is it archived redundantly?)
When will the dataset be released/first distributed? (Is there a canonical paper/reference for this dataset?)
What license (if any) is it distributed under? Are there any copyrights on the data?
Are there any fees or access/export restrictions?
Any other comments?
<b>Dataset Maintenance</b>
Who is supporting/hosting/maintaining the dataset? How does one contact the owner/curator/manager of the dataset (e.g., email address, or other contact info)?
Will the dataset be updated? How often and by whom? How will updates/revisions be documented and communicated (e.g., mailing list, GitHub)? Is there an erratum?
If the dataset becomes obsolete how will this be communicated?
Is there a repository to link to any/all papers/systems that use this dataset?
If others want to extend/augment/build on this dataset, is there a mechanism for them to do so? If so, is there a process for tracking/assessing the quality of those contributions. What is the process for communicating/distributing these contributions to users?
Any other comments?

<b>Legal &amp; Ethical Considerations</b>
If the dataset relates to people (e.g., their attributes) or was generated by people, were they informed about the data collection? (e.g., datasets that collect writing, photos, interactions, transactions, etc.)
If it relates to other ethically protected subjects, have appropriate obligations been met? (e.g., medical data might include information collected from animals)
If it relates to people, were there any ethical review applications/reviews/approvals? (e.g., Institutional Review Board applications)
If it relates to people, were they told what the dataset would be used for and did they consent? What community norms exist for data collected from human communities? If consent was obtained, how? Were the people provided with any mechanism to revoke their consent in the future or for certain uses?
If it relates to people, could this dataset expose people to harm or legal action? (e.g., financial social or otherwise) What was done to mitigate or reduce the potential for harm?
If it relates to people, does it unfairly advantage or disadvantage a particular social group? In what ways? How was this mitigated?
If it relates to people, were they provided with privacy guarantees? If so, what guarantees and how are these ensured?
Does the dataset comply with the EU General Data Protection Regulation (GDPR)? Does it comply with any other standards, such as the US Equal Employment Opportunity Act?
Does the dataset contain information that might be considered sensitive or confidential? (e.g., personally identifying information)
Does the dataset contain information that might be considered inappropriate or offensive?
Any other comments?

Gebru, Timnit, Jamie Morgenstern, Briana Vecchione, Jennifer Wortman Vaughan, Hanna Wallach, Hal Daumé III, and Kate Crawford. "Datasheets for Datasets."

# Data Profiling

## Adult Data Set



Predict whether income exceeds \$50K/yr based on census data. Also known as "Census Income" dataset.

Data Set Characteristics:	Multivariate	Number of Instances:	488 42	Area:	Social
Attribute Characteristics:	Categorical, Integer	Number of Attributes:	14	Date Donated	1996-05-01
Associated Tasks:	Classification	Missing Values?	Yes	Number of Web Hits:	1953013

<https://archive.ics.uci.edu/ml/datasets/adult>

# Data Profiling

## Adult Data Set

Source:

Donor:

Ronny Kohavi and Barry Becker

Data Mining and Visualization

Silicon Graphics.

e-mail: ronnyk '@' live.com for questions.



### Data Set Information:

Extraction was done by Barry Becker from the 1994 Census database. A set of reasonably clean records was extracted using the following conditions: ((AAGE>16) && (AGI>100) && (AFNLWGT>1)&& (HRSWK>0))

Prediction task is to determine whether a person makes over 50K a year.

<https://archive.ics.uci.edu/ml/datasets/adult>

# Data Profiling

## Adult Data Set

Listing of attributes:  
>50K, <=50K.

age: continuous.

workclass: Private, Self-emp-not-inc, Self-emp-inc, Federal-gov, Local-gov, State-gov, Without-pay, Never-worked.

fnlwgt: continuous.

education: Bachelors, Some-college, 11th, HS-grad, Prof-school, Assoc-acdm, Assoc-voc, 9th, 7th-8th, 12th, Masters, 1st-4th, 10th, Doctorate, 5th-6th, Preschool.

education-num: continuous.

marital-status: Married-civ-spouse, Divorced, Never-married, Separated, Widowed, Married-spouse-absent, Married-AF-spouse.

occupation: Tech-support, Craft-repair, Other-service, Sales, Exec-managerial, Prof-specialty, Handlers-cleaners, Machine-op-inspct, Adm-clerical, Farming-fishing, Transport-moving, Priv-house-serv, Protective-serv, Armed-Forces.

relationship: Wife, Own-child, Husband, Not-in-family, Other-relative, Unmarried.

race: White, Asian-Pac-Islander, Amer-Indian-Eskimo, Other, Black.

sex: Female, Male.

capital-gain: continuous.

capital-loss: continuous.

hours-per-week: continuous.

native-country: United-States, Cambodia, England, Puerto-Rico, Canada, Germany, Outlying-US(Guam-USVI-etc), India, Japan, Greece, South, China, Cuba, Iran, Honduras, Philippines, Italy, Poland, Jamaica, Vietnam, Mexico, Portugal, Ireland, France, Dominican-Republic, Laos, Ecuador, Taiwan, Haiti, Columbia, Hungary, Guatemala, Nicaragua, Scotland, Thailand, Yugoslavia, El-Salvador, Trinadad&Tobago, Peru, Hong, Holand-Netherlands.



<https://archive.ics.uci.edu/ml/datasets/adult>

# Data Profiling



## Overview

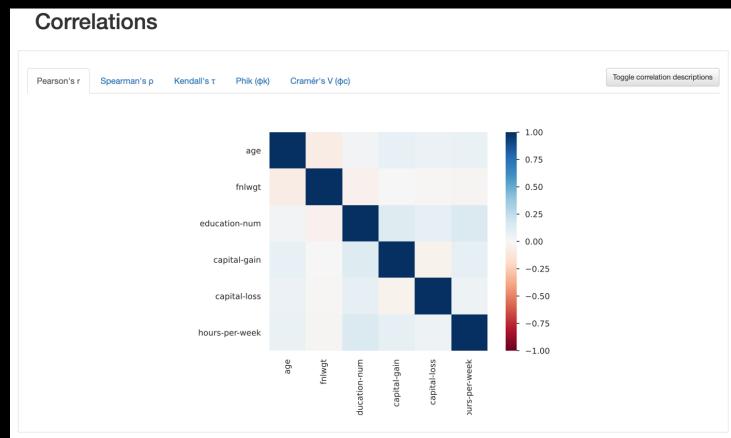
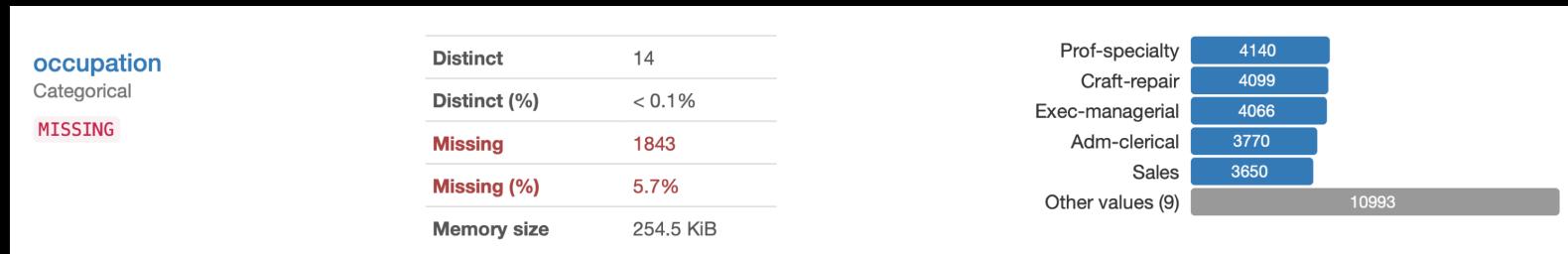
Overview   Dataset   Variables   Warnings 6   Reproduction

### Warnings

Dataset has 25 (0.1%) duplicate rows	Duplicates
<code>workclass</code> has 1836 (5.6%) missing values	Missing
<code>occupation</code> has 1843 (5.7%) missing values	Missing
<code>native-country</code> has 583 (1.8%) missing values	Missing
<code>capital-gain</code> has 29849 (91.7%) zeros	Zeros
<code>capital-loss</code> has 31042 (95.3%) zeros	Zeros

[https://pandas-profiling.github.io/pandas-profiling/examples/master/census/census\\_report.html](https://pandas-profiling.github.io/pandas-profiling/examples/master/census/census_report.html)

# Data Profiling



[https://pandas-profiling.github.io/pandas-profiling/examples/master/census/census\\_report.html](https://pandas-profiling.github.io/pandas-profiling/examples/master/census/census_report.html)

# Dataset Inspection Schema

Scope/Problem		Dirty Data	Reasons/Remarks
Attribute	Illegal values	bdate=30.13.70	values outside of domain range
Record	Violated attribute dependencies	age=22, bdate=12.02.70	age = current year - birth year should hold
Record type	Uniqueness violation	emp <sub>1</sub> =(name="John Smith", SSN="123456"); emp <sub>2</sub> =(name="Peter Miller", SSN="123456")	uniqueness for SSN (social security number) violated
Source	Referential integrity violation	emp=(name="John Smith", deptno=127)	referenced department (127) not defined

Rahm, Erhard, and Hong Hai Do. "Data cleaning: Problems and current approaches." IEEE Data Eng. Bull. 23, no. 4 (2000): 3-13.

# Dataset Inspection      Instance Constraints

Scope/Problem		Dirty Data	Reasons/Remarks
<b>Attribute</b>	Missing values	phone=9999-999999	unavailable values during data entry (dummy values or null)
	Misspellings	city="Liipzig"	usually typos, phonetic errors
	Cryptic values, Abbreviations	experience="B"; occupation="DB Prog."	
	Embedded values	name="J. Smith 12.02.70 New York"	multiple values entered in one attribute (e.g. in a free-form field)
	Misfielded values	city="Germany"	
<b>Record</b>	Violated attribute dependencies	city="Redmond", zip=77777	city and zip code should correspond
<b>Record type</b>	Word transpositions	name <sub>1</sub> = "J. Smith", name <sub>2</sub> = "Miller P."	usually in a free-form field
	Duplicated records	emp <sub>1</sub> =(name="John Smith",...); emp <sub>2</sub> =(name="J. Smith",...)	same employee represented twice due to some data entry errors
	Contradicting records	emp <sub>1</sub> =(name="John Smith", bdate=12.02.70); emp <sub>2</sub> =(name="John Smith", bdate=12.12.70)	the same real world entity is described by different values
<b>Source</b>	Wrong references	emp=(name="John Smith", deptno=17)	referenced department (17) is defined but wrong

Rahm, Erhard, and Hong Hai Do. "Data cleaning: Problems and current approaches." IEEE Data Eng. Bull. 23, no. 4 (2000): 3-13.

# Dataset Verification Tools



constraint	semantic
statistics	
hasSize	custom validation of the number of records
hasTypeConsistency	custom validation of the maximum fraction of values of the same data type
hasCountDistinct	custom validation of the number of distinct non-null values in a column
hasApproxCountDistinct	custom validation of the approx. number of distinct non-null values
hasMin	custom validation of a column's minimum value
hasMax	custom validation of a column's maximum value
hasMean	custom validation of a column's mean value
hasStandardDeviation	custom validation of a column's standard deviation
hasApproxQuantile	custom validation of a particular quantile of a column (approx.)
hasEntropy	custom validation of a column's entropy
hasMutualInformation	custom validation of a column pair's mutual information
hasHistogramValues	custom validation of column histogram
hasCorrelation	custom validation of a column pair's correlation
time	
hasNoAnomalies	validation of anomalies in time series of metric values

Schelter, Sebastian, Dustin Lange, Philipp Schmidt, Meltem Celikel, Felix Biessmann, and Andreas Grafberger.  
"Automating large-scale data quality verification." Proceedings of the VLDB Endowment 11, no. 12 (2018): 1781-1794.

# Dataset Verification Tools



```
import com.amazon.deequ.VerificationSuite, VerificationResult
import com.amazon.deequ.VerificationResult.checkResultsAsDataFrame
import com.amazon.deequ.checks.{Check, CheckLevel}

val verificationResult: VerificationResult = { VerificationSuite()
    // data to run the verification on
    .onData(dataset)
    // define a data quality check
    .addCheck(
        Check(CheckLevel.Error, "Review Check")
            .hasSize(_ >= 3000000) // at least 3 million rows
            .hasMin("star_rating", _ == 1.0) // min is 1.0
            .hasMax("star_rating", _ == 5.0) // max is 5.0
            .isComplete("review_id") // should never be NULL
            .isUnique("review_id") // should not contain duplicates
            .isComplete("marketplace") // should never be NULL
            // contains only the listed values
            .isContainedIn("marketplace", Array("US", "UK", "DE", "JP", "FR"))
            .isNonNegative("year") // should not contain negative values
    // compute metrics and verify check conditions
    .run()
}

// convert check results to a Spark data frame
val resultDataFrame = checkResultsAsDataFrame(spark, verificationResult)
```

constraint	constraint status	constraint_message
SizeConstraint(Size(None))	Success	
MinimumConstraint(Minimum(star_rating,None))	Success	
MaximumConstraint(Maximum(star_rating,None))	Success	
CompletenessConstraint(Completeness(review_id,None))	Success	
UniquenessConstraint(Uniqueness(List(review_id)))	Failure	Value: 0.9926566948782706 does not meet the constraint requirement!
CompletenessConstraint(Completeness(marketplace,None))	Success	
ComplianceConstraint(Compliance(marketplace contained in US,UK,DE,JP,FR,marketplace IS NULL OR marketplace IN ('US','UK','DE','JP','FR'),None))	Success	
ComplianceConstraint(Compliance(year is non-negative,COALESCE(year, 0.0) >= 0,None))	Success	

<https://aws.amazon.com/blogs/big-data/test-data-quality-at-scale-with-deequ/>

# Dataset Verification Tools



```
expect_column_values_to_not_be_null  
expect_column_values_to_match_regex  
expect_column_values_to_be_unique  
expect_column_values_to_match_strftime_format  
expect_table_row_count_to_be_between  
expect_column_median_to_be_between
```

```
[49]: my_df.expect_column_values_to_be_in_set("PClass", ["1st", "2nd", "3rd"], mostly=.99)  
  
[49]: {  
    "success": true,  
    "meta": {},  
    "result": {  
        "element_count": 1313,  
        "missing_count": 0,  
        "missing_percent": 0.0,  
        "unexpected_count": 1,  
        "unexpected_percent": 0.07616146230007616,  
        "unexpected_percent_nonmissing": 0.07616146230007616,  
        "partial_unexpected_list": [  
            "*"  
        ]  
    },  
    "exception_info": null  
}
```

```
{  
  "data_asset_type": "Dataset",  
  "expectation_suite_name": "taxi.demo",  
  "expectations": [  
    ...  
    {  
      "expectation_type": "expect_column_values_to_not_be_null",  
      "kwargs": {  
        "column": "passenger_count"  
      },  
      "meta": {  
        "BasicSuiteBuilderProfiler": {  
          "confidence": "very low"  
        }  
      }  
    },  
    {  
      "expectation_type": "expect_column_distinct_values_to_be_in_set",  
      "kwargs": {  
        "column": "passenger_count",  
        "value_set": [  
          1.0,  
          2.0,  
          3.0,  
          4.0,  
          5.0,  
          6.0  
        ]  
      },  
      "meta": {  
        "BasicSuiteBuilderProfiler": {  
          "confidence": "very low"  
        }  
      }  
    },  
    ...  
  ]  
}
```

## Expectation Suite



# Dataset Verification Tools



great\_expectations [Home](#) / taxi.demo / 20200819T024609.241003Z / 2020-08-19T02:46:09.241003+00:00 / cbb8bd044ccaa28d4db5e3d59c0be748



### Expectation Validation Result

Evaluates whether a batch of data matches expectations.

Actions	
Validation Filter:	
<a href="#">Show All</a>	<a href="#">Failed Only</a>
<a href="#">How to Edit This Suite</a>	
<a href="#">Show Walkthrough</a>	

**Overview**  
Expectation Suite: [taxi.demo](#)  
Status: ✓ Succeeded

**Statistics**

Evaluated Expectations	6
Successful Expectations	6
Unsuccessful Expectations	0
Success Percent	100%

[Show more info...](#)

**Table-Level Expectations**

Status	Expectation	Observed Value
<span style="color: green;">✓</span>	Must have between <code>9000</code> and <code>11000</code> rows.	10000
<span style="color: green;">✓</span>	Must have exactly <code>18</code> columns.	18
<span style="color: green;">✓</span>	Must have these columns in this order: <code>vendor_id</code> , <code>pickup_datetime</code> , <code>dropoff_datetime</code> , <code>passenger_count</code> , <code>trip_distance</code> , <code>rate_code_id</code> , <code>store_and_fwd_flag</code> , <code>pickup_location_id</code> , <code>dropoff_location_id</code> , <code>payment_type</code> , <code>fare_amount</code> , <code>extra</code> , <code>mta_tax</code> , <code>tip_amount</code> , <code>tolls_amount</code> , <code>improvement_surcharge</code> , <code>total_amount</code> , <code>congestion_surcharge</code>	<code>['vendor_id', 'pickup_datetime', 'dropoff_datetime', 'passenger_count', 'trip_distance', 'rate_code_id', 'store_and_fwd_flag', 'pickup_location_id', 'dropoff_location_id', 'payment_type', 'fare_amount', 'extra', 'mta_tax', 'tip_amount', 'tolls_amount', 'improvement_surcharge', 'total_amount', 'congestion_surcharge']</code>

**Table of Contents**

- [Overview](#)
- [Table-Level Expectations](#)
- [passenger\\_count](#)

**Search**

# Data integration from Multiple Sources

**Customer** (source 1)

CID	Name	Street	City	Sex
11	Kristen Smith	2 Hurley Pl	South Fork, MN 48503	0
24	Christian Smith	Hurley St 2	S Fork MN	1

**Client** (source 2)

Cno	LastName	FirstName	Gender	Address	Phone/Fax
24	Smith	Christoph	M	23 Harley St, Chicago IL, 60633-2394	333-222-6542 / 333-222-6599
493	Smith	Kris L.	F	2 Hurley Place, South Fork MN, 48503-5998	444-555-6666

**Customers** (integrated target with cleaned data)

No	LName	FName	Gender	Street	City	State	ZIP	Phone	Fax	CID	Cno
1	Smith	Kristen L.	F	2 Hurley Place	South Fork	MN	48503-5998	444-555-6666		11	493
2	Smith	Christian	M	2 Hurley Place	South Fork	MN	48503-5998			24	
3	Smith	Christoph	M	23 Harley Street	Chicago	IL	60633-2394	333-222-6542	333-222-6599		24



Rahm, Erhard, and Hong Hai Do. "Data cleaning: Problems and current approaches." IEEE Data Eng. Bull. 23, no. 4 (2000): 3-13.

# Data Drifting

- The change in model input data that leads to model performance degradation.
- Causes
  - Upstream process changes, such as a sensor being replaced that changes the units of measurement from inches to centimeters.
  - Data quality issues, such as a broken sensor always reading 0.
  - Natural drift in the data, such as mean temperature changing with the seasons.
  - Change in relation between features, or covariate shift.

<https://docs.microsoft.com/en-us/azure/machine-learning/how-to-monitor-datasets>

# Data Monitoring

- Detect and alert to data drift on new data in a dataset.
- Analyze historical data for drift.
- Profile new data over time.
- Monitor model performance

<https://docs.microsoft.com/en-us/azure/machine-learning/how-to-monitor-datasets>

# Data Monitoring

Settings ▶ Analyze existing data ⏪ Refresh

## Summary

Summary of the drift metrics captured with the latest run on 2020-06-11

Drift magnitude ⓘ	Top drifting features ⓘ
<b>85%</b>	temperature 68%
	countryOrRegion 13%
	wban 9%

Threshold ⓘ **20%**

## Drift runs

Last run  
1 days 2 hrs ago ⏪  
Next run  
5 days 22 hrs

## Drift frequency

Week

## Monitor timeseries

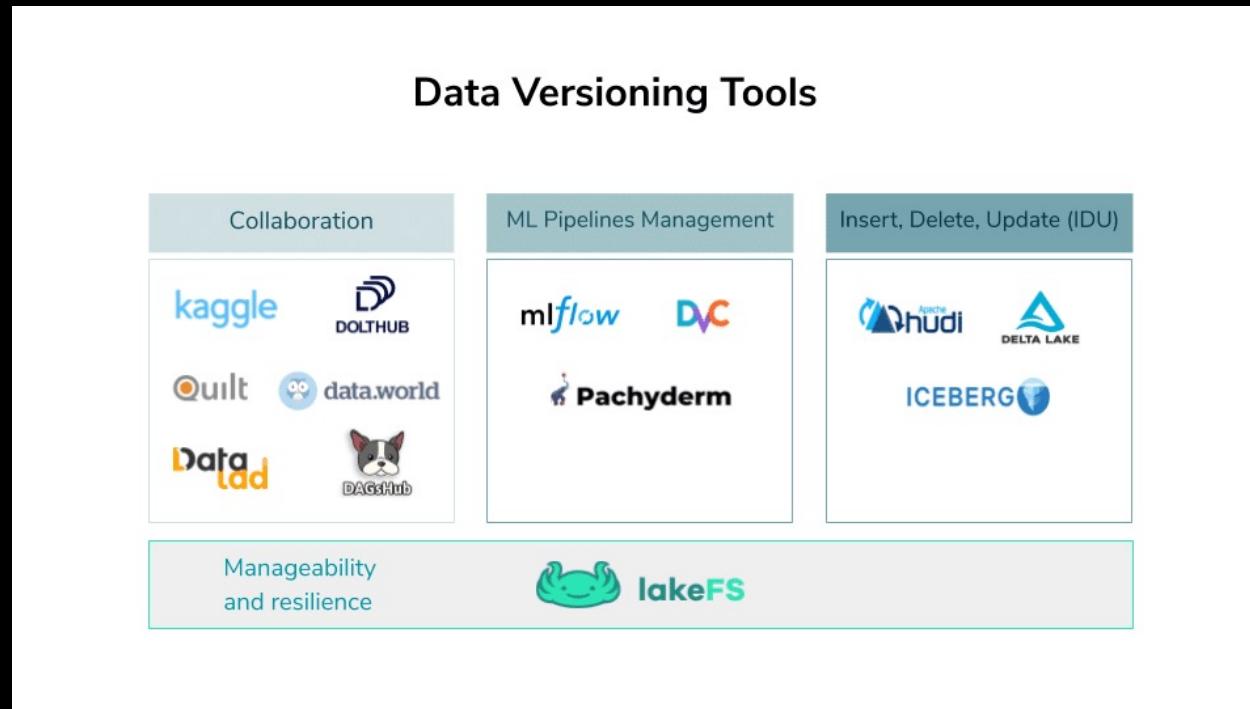
this chart shows the date range for which baseline, target and drift data is available.

Baseline dataset  
**target**  
Target dataset  
**baseline-201...**  
Drift Monitor  
**weather-mon...**

The timeline chart displays vertical blue bars representing data availability over time. The x-axis marks dates from 19-08-04 to 19-09-29. Blue bars are present at approximately 19-08-04, 19-08-05, 19-08-06, 19-08-07, 19-08-08, 19-08-09, 19-08-10, 19-08-11, 19-08-12, 19-08-13, 19-08-14, 19-08-15, 19-08-16, 19-08-17, 19-08-18, 19-08-19, 19-08-20, 19-08-21, 19-08-22, 19-08-23, 19-08-24, 19-08-25, 19-08-26, 19-08-27, 19-08-28, and 19-08-29. There are gaps in the data availability between these points.

<https://docs.microsoft.com/en-us/azure/machine-learning/how-to-monitor-datasets>

# Data/Experiment Version Control



**Insert, Delete, Update (IDU)**

  
Apache Hudi



  
ICEBERG

Manageability  
and resilience

  
lakeFS

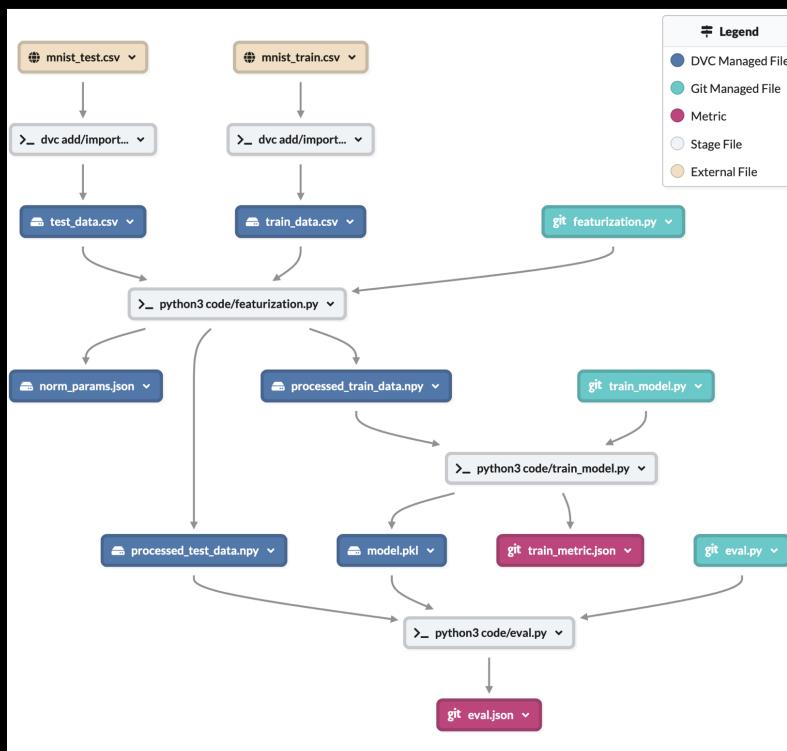
<https://lakefs.io/data-versioning/>

# Data/Experiment Version Control

The screenshot shows the Kaggle web interface. On the left, there's a sidebar with navigation links: Create, Home, Competitions, Datasets (which is selected), Code, Discussions, Courses, and More. The main area displays a dataset titled "Apple Stock Price (All Time)" with a subtitle "Updated Apple Stock Price, right from its IPO (12 Dec 1980)". Below the title is a large Apple logo. A search bar is at the top of the main content area. The central part of the screen shows the "History" of the dataset. It lists two entries:

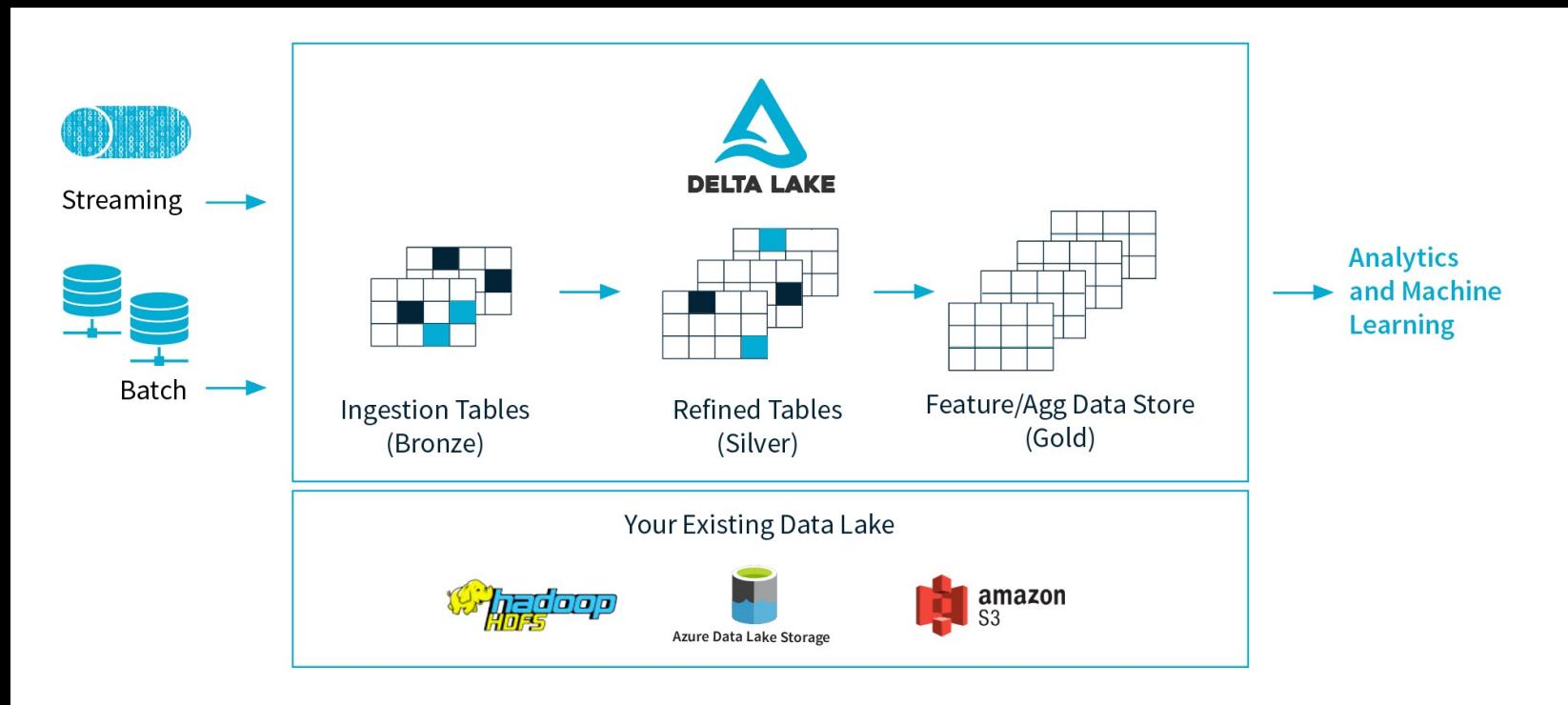
- 8 days ago**: Version 2, Data Update 2021/09/29, 1 modified. Changes include: File Apple.csv description changed; Column In Apple.csv: Column Date description changed; Column In Apple.csv: Column Open description changed; Column In Apple.csv: Column High description changed; Column In Apple.csv: Column Low description changed. A button "Show 3 more changes..." is visible.
- 14 days ago**: Metadata, 9 metadata changes: Apple.csv. Changes include: File Apple.csv description changed; Column In Apple.csv: Column Date description changed; Column In Apple.csv: Column Volume description changed; Column In Apple.csv: Column Low description changed.

# Data/Experiment Version Control



<https://dagshub.com/leo/DAGsHub-Tutorial-MNIST>

# Data/Experiment Version Control



<https://delta.io>