Grand Valley State University
www.gvsu.edu

Cloud Computing Normal and Big Data

CIS437
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Adapted from Google Cloud Computing Foundations, Overview of Cloud Computing (Wufka & Canonico)

FOR LATER

https://www.cloudskillsboost.google/focuses/8391?catalog_rank=%7B%22rank%22%3A2%2C%22num_filters%22%3A0%2C%22has_search%22%3Atrue%7D&parent=catalog&search_id=39518942

First off, what types of data *do we have to deal with?*

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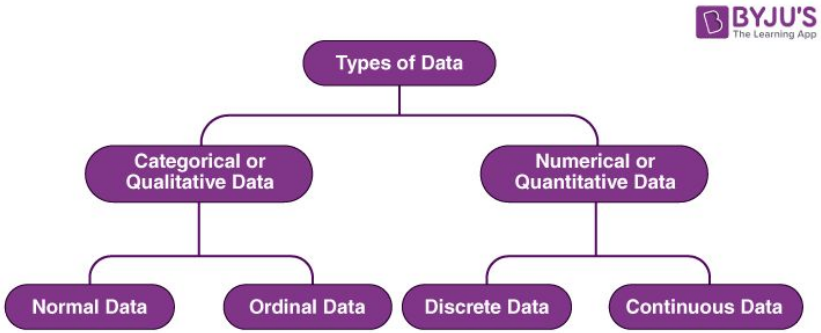
Binary

- Blobs ... think images, archives, general files, etc.

Text

- Strings, numbers, JSON, etc.

Note, if you look to data science you'll have many, many more classifications We just care about how to store and retrieve it ... for now

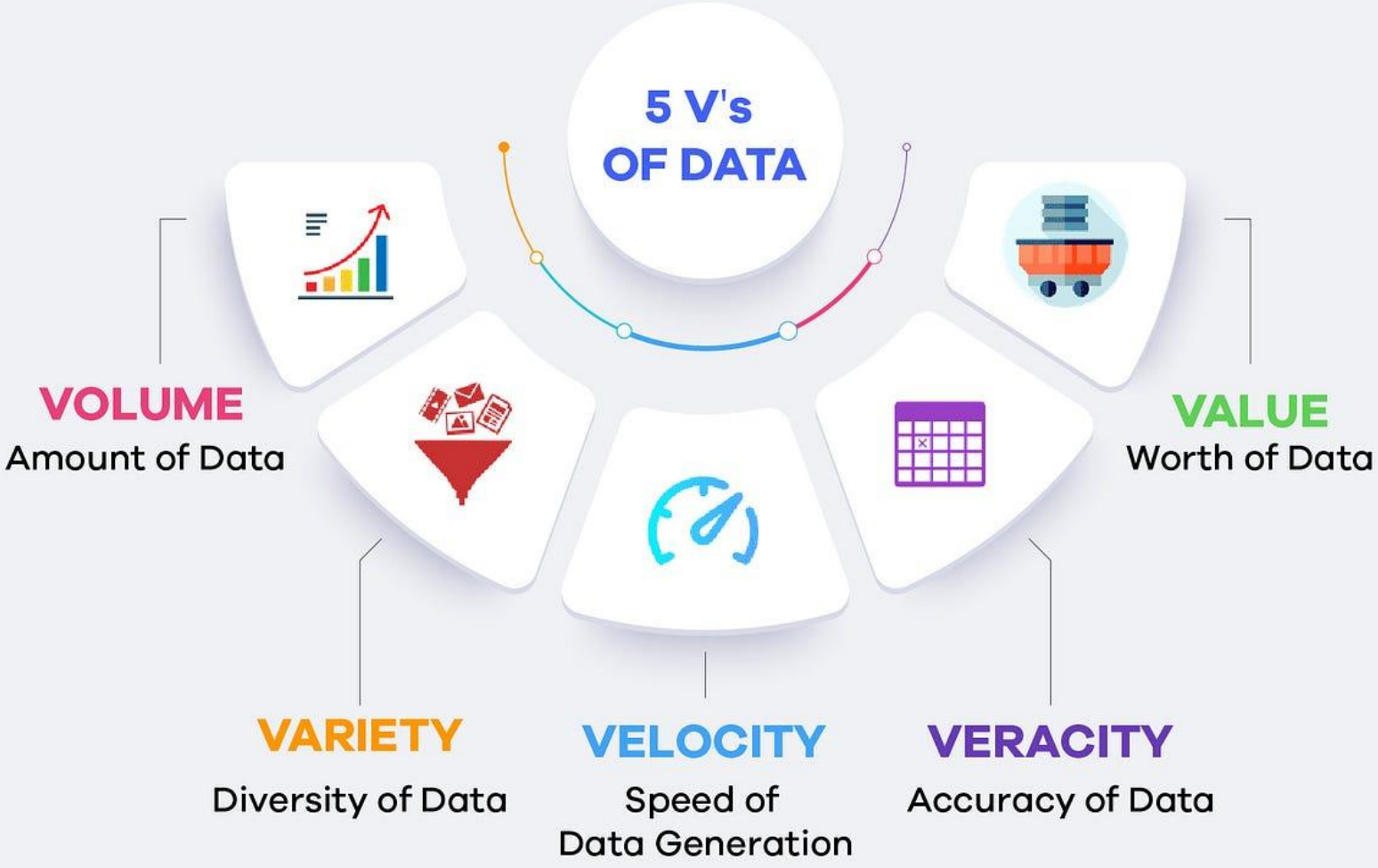


Interestingly, that's not as important for us

The question becomes more:

1) How *much* data do we have to deal with?
2) How *often* does the data change?
3) At what *speed* does the data come in/out
4) How *reliable* is the data?
5) How *valuable* is the data?

Anybody know what this is leading to?


5 V's
OF DATA
VOLUME
Amount of Data
VARIETY
Diversity of Data
VELOCITY
Speed of
Data Generation
VERACITY
Accuracy of Data
VALUE
Worth of Data

Essentially, big or normal data?

Big data:

- Enormous amount of data to manage (think, petabytes/exabytes)
- Exceedingly complex

Normal data:

- Things you can store in a database without performance considerations
- Files you can store off to some sort of bucket-like system

https://www.312analytics.com/what-is-the-difference-between-big-and-small-data/

	Big Data	Small Data
Data Condition	Always unstructured, not ready for analysis, many relational database tables that need merged	Ready for analysis, flat file, no need for merging tables.
Location	Cloud, Offshore, SQL Server, etc.	Database, local PC
Data Size	Over 50K Variables, over 50K individuals, random samples, unstructured	File that is in a spreadsheet, that can be viewed on a few sheets of paper
Data Purpose	No intended purpose	Intended purpose for Data Collection

Storage options

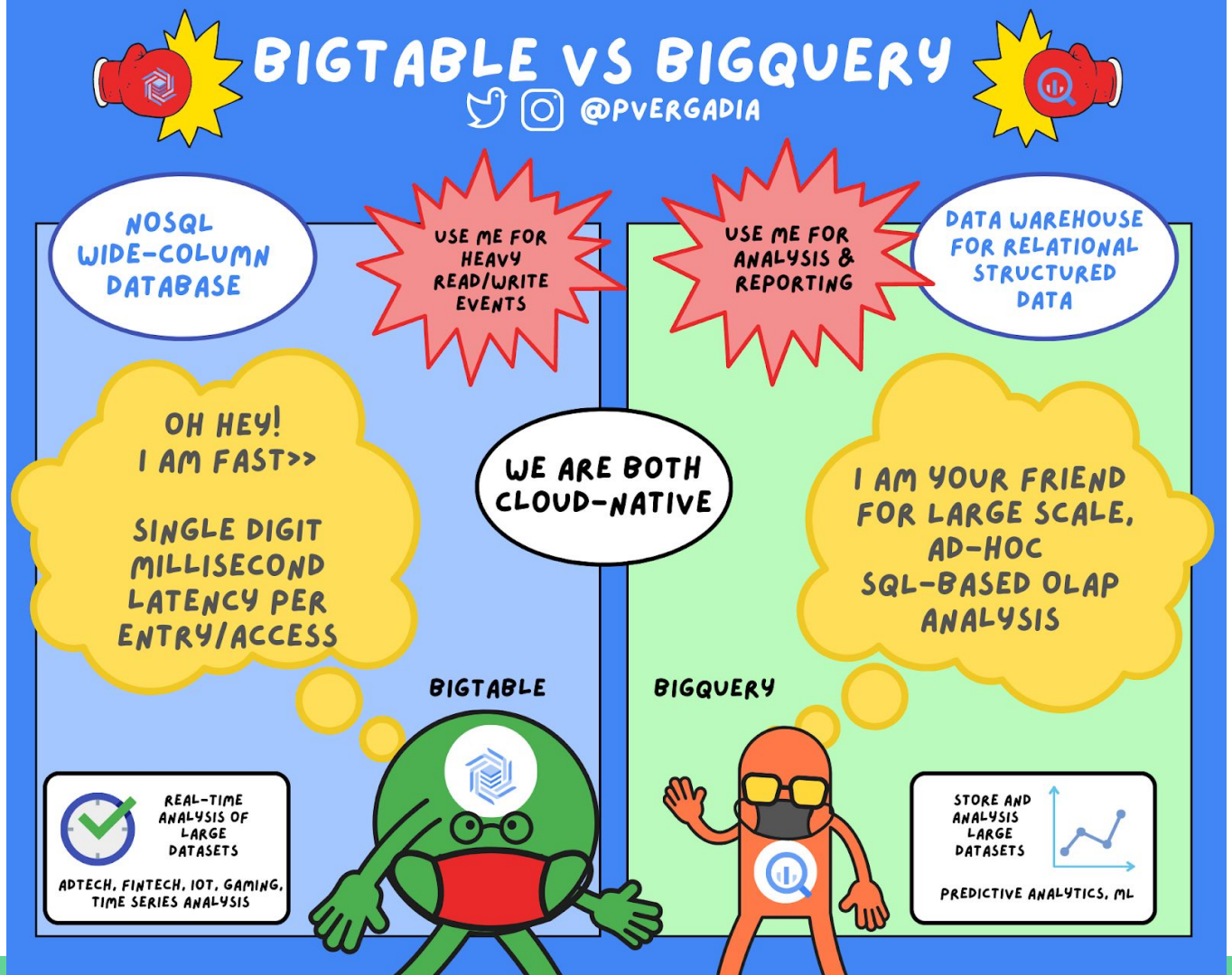
Buckets
- File storage

CloudSQL / Spanner
- Relational database

BigTable
- NoSQL

BigQuery:
- Relational (big) data warehouse

BigLake: storage/analytics for data lakes


BIGTABLE VS BIGQUERY
@PVERGADIA
NOSQL WIDE-COLUMN DATABASE
USE ME FOR HEAVY READ/WRITE EVENTS
USE ME FOR ANALYSIS & REPORTING
DATA WAREHOUSE FOR RELATIONAL STRUCTURED DATA
OH HEY! I AM FAST>>
SINGLE DIGIT MILLISECOND LATENCY PER ENTRY/ACCESS
WE ARE BOTH CLOUD-NATIVE
I AM YOUR FRIEND FOR LARGE SCALE, AD-HOC SQL-BASED OLAP ANALYSIS
BIGTABLE
BIGQUERY
REAL-TIME ANALYSIS OF LARGE DATASETS
ADTECH, FINTECH, IOT, GAMING, TIME SERIES ANALYSIS
STORE AND ANALYSIS LARGE DATASETS
PREDICTIVE ANALYTICS, ML

What is a data lake?

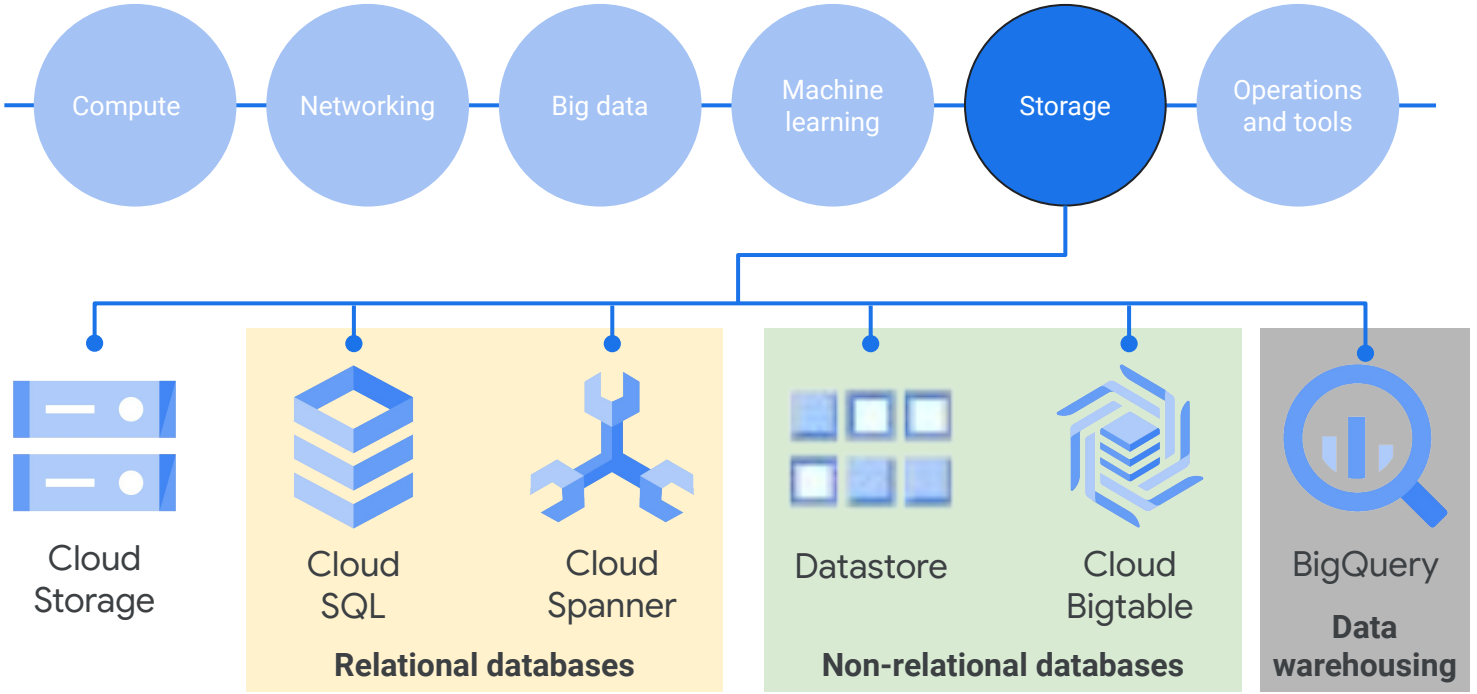
https://aws.amazon.com/what-is/data-lake/

"A data lake is a centralized repository that allows you to store all your structured and unstructured data at any scale. You can store your data as-is, without having to first structure the data, and run different types of analytics—from dashboards and visualizations to big data processing, real-time analytics, and machine learning to guide better decisions."

Think of it as a place to store different types of data for generating reports/analytics to make business decisions

- Or, a data warehouse at scale

Google Cloud has many storage options

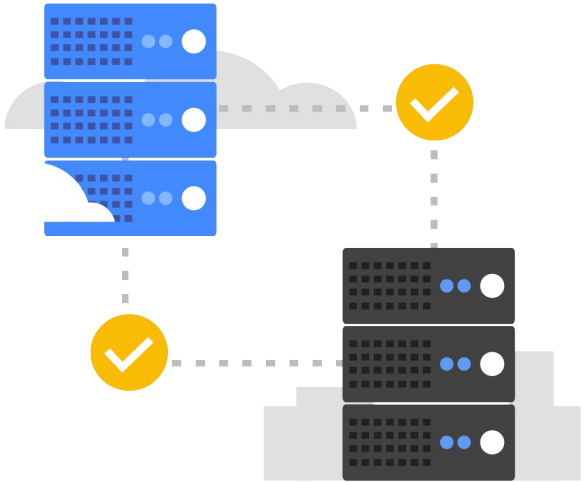


There are three common use cases for cloud storage

1. Content storage and delivery
2. Storage for data analytics and general compute
3. Backup and archival storage

For users with databases, Google has two priorities

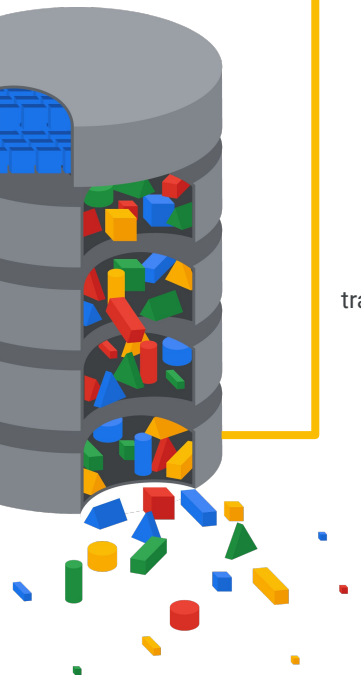
- Migrate existing databases to the cloud, and move them to the right service.
- Innovate, build, or rebuild for the cloud, take advantage of mobile, and plan for future growth.



Structured versus unstructured data

First_Name	Last_Name	Address	City	Age
Sherlock	Holmes	12 Main St	Mesa	60
James	Bond	23 Old St	Napa	43
Scarlett	O'Hara	34 New St	Derby	23
Marge	Simpson	56 West St	Cody	36

Structured data



Unstructured data


Transactions


Voice transcriptions


Online communities


Notes & text fields


Call center


Ratings & reviews

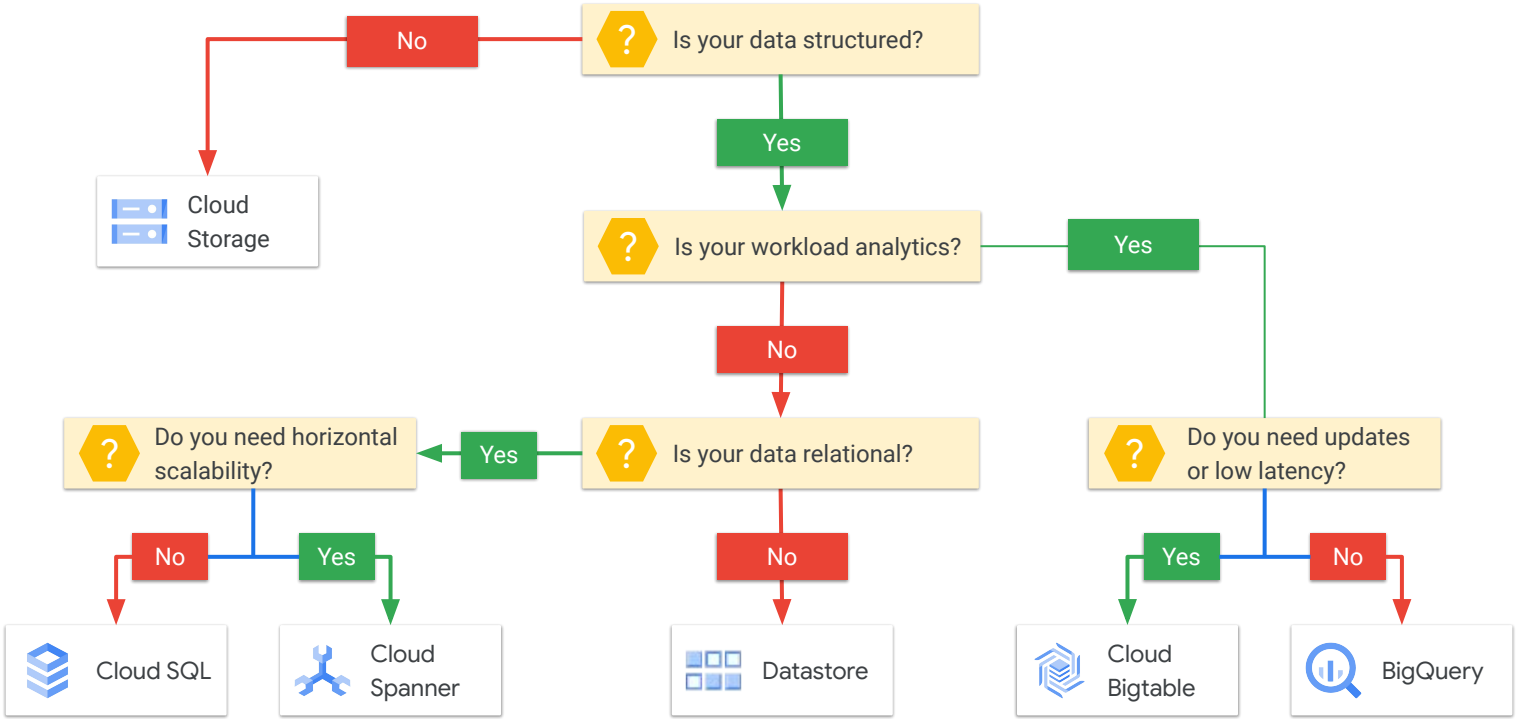

Social media


Email


Chat


Surveys

What type of storage will meet my needs best?



Cloud Storage

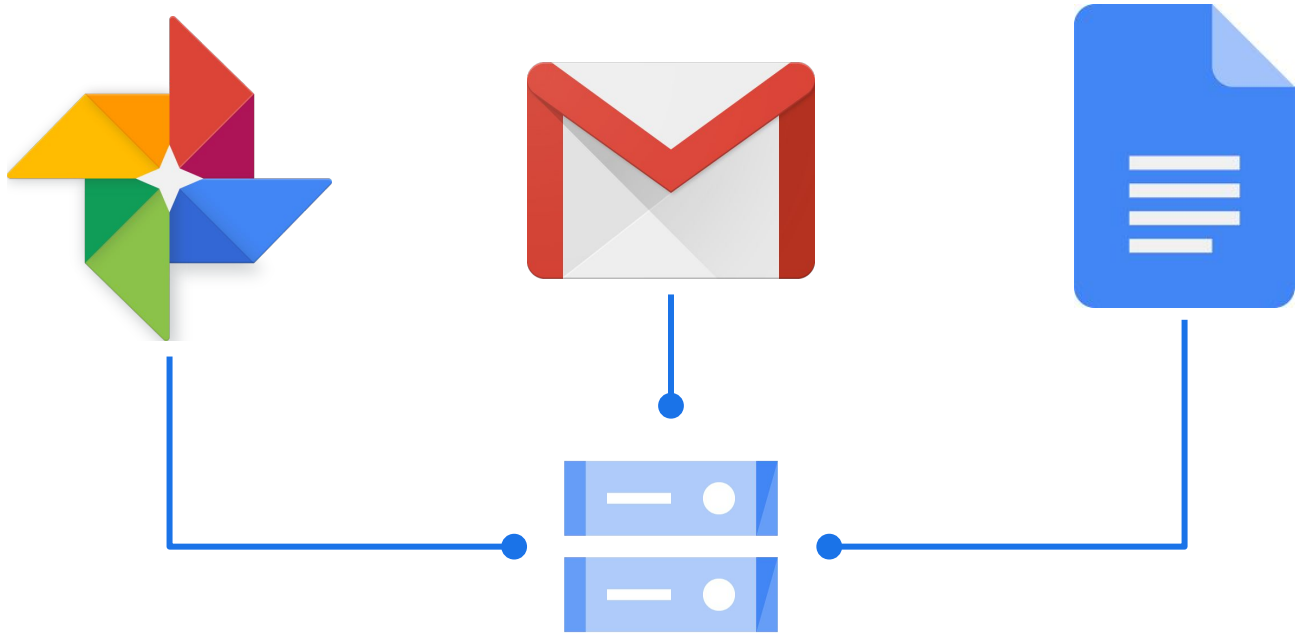
Object-based storage

Uses concept of "buckets"
- Logical containers for files
- Usual access rights apply

https://cloud.google.com/storage

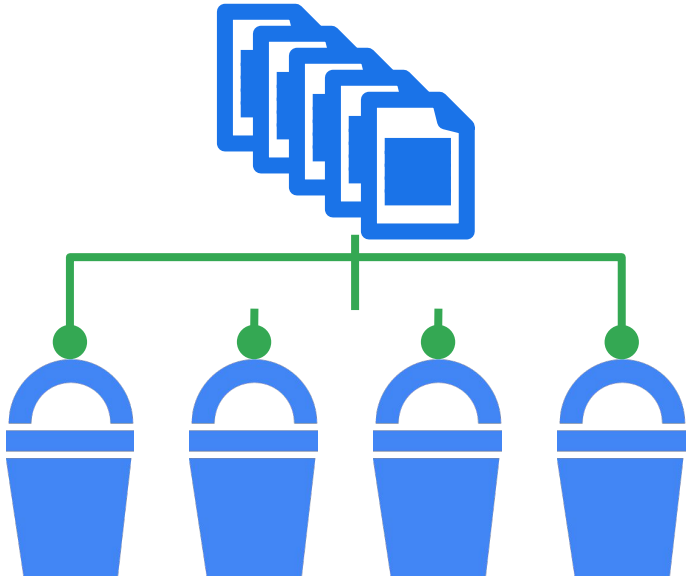
Storage type	Description	Best for
Standard storage	Storage for data that is frequently accessed ("hot" data) and/or stored for only brief periods of time.	"Hot" data, including websites, streaming videos, and mobile apps.
Nearline storage	Low cost, highly durable storage service for storing infrequently accessed data.	Data that can be stored for 30 days.
Coldline storage	A very low cost, highly durable storage service for storing infrequently accessed data.	Data that can be stored for 90 days.
Archive storage	The lowest cost, highly durable storage service for data archiving, online backup, and disaster recovery.	Data that can be stored for 365 days.

Google uses Cloud Storage too!



Cloud Storage files are organized into buckets

- Globally unique name
- Location (region, dual-region, or multi-region)
- Storage class
- IAM policies or access-control lists
- Object versioning setting
- Object lifecycle management rules



Lab Intro

Cloud Storage: Qwik Start - CLI/SDK

Create a storage bucket, upload objects, create folders and subfolders, and make objects publicly accessible using the Google Cloud command line.

You can find the lab here.

Cloud SQL

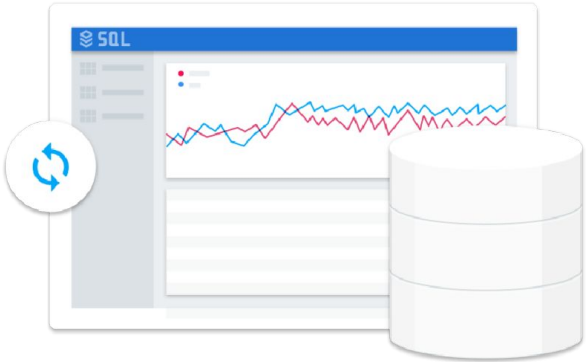
Now, time for database storage

Options are relational or non-relational (NoSQL)

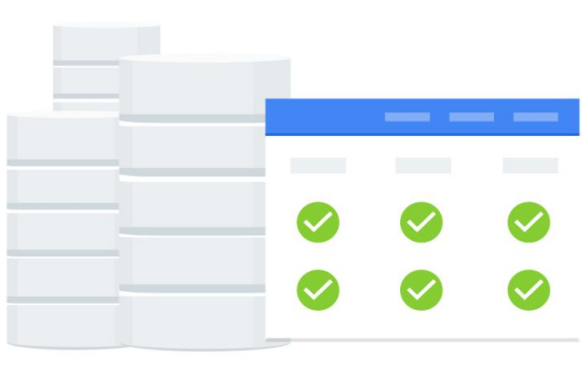
What is a database and how is it used?

A collection of information organized so that it can easily be accessed and managed.

Computer applications run databases to get a fast answer to questions.



Relational databases are the most common



Relational database management systems
= RDBMS
= relational databases
= SQL databases

Suitable use cases:

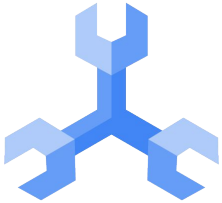
- Have a well-structured data model.
- Need transactions.
- Ability to join data across tables to retrieve complex data combinations.

Options for SQL-based managed services

Cloud SQL

MySQL, PostgreSQL, and SQL Server databases as a service

- Automatic replication
- Managed backups
- Vertical scaling (read and write)
- Horizontal scaling (read)



Cloud Spanner

- Automatic replication
- Strong global consistency
- Managed instances with high availability
- SQL (ANSI SQL 2011 with extensions)

Cloud Spanner

Note: $$$

The difference between Cloud Spanner and other databases

1. Familiar relational database structure
2. Scales to very large databases
3. Strong external consistency
4. Reduces operational overheads

Get the best of relational database structure and non-relational database scale and performance

Scale + SQL

Scales horizontally.

Low latency, transactional consistency, and high availability.

Future-proofs database backends.

Fully managed

Create or scale a globally replicated database in a few clicks.

Synchronous replication and maintenance built in.

Launch faster

Relational semantics.

ACID transactions.

Schemas.

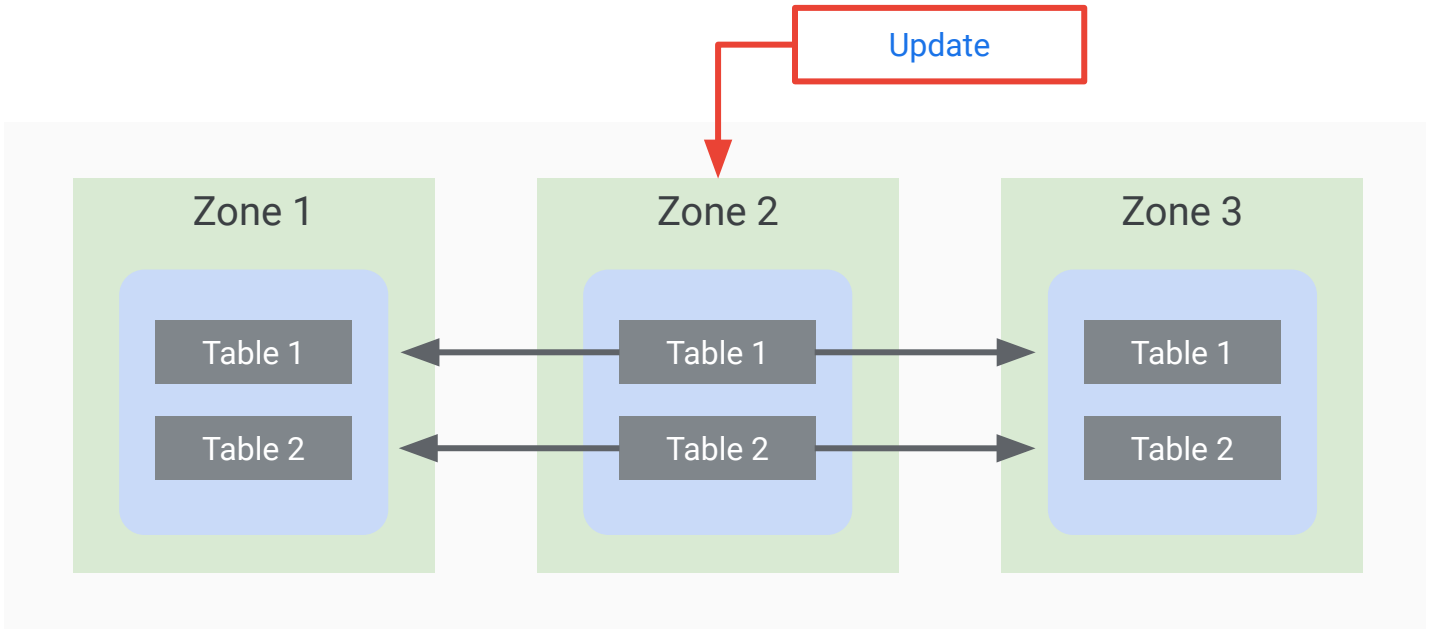
Enterprise grade security

Data-layer encryption.

IAM integration.

Audit logging.

How Cloud Spanner works

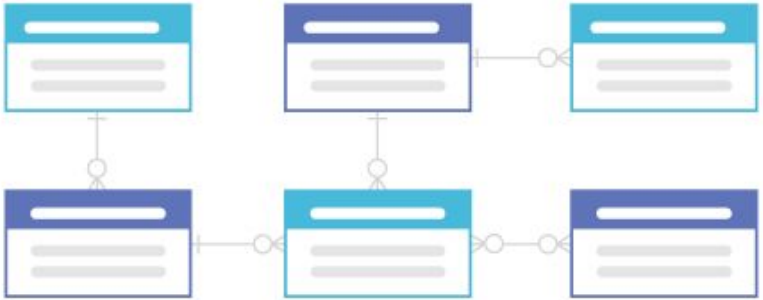


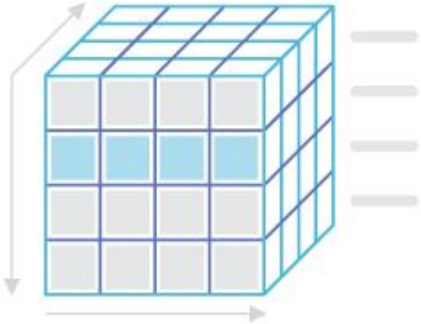
NoSQL options

Difference to relational databases?

SQL

Relational Database Management Systems (RDBMS)

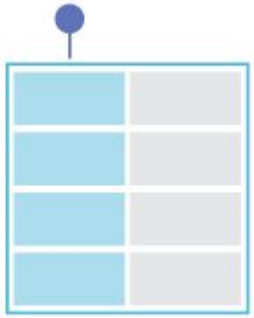




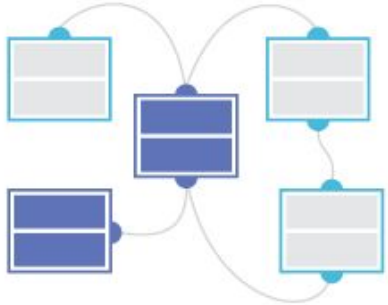
Online Analytical Processing (OLAP) Cube

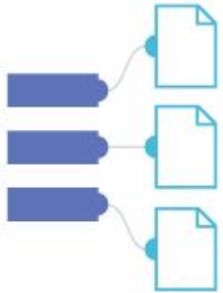
NoSQL

Key-Value

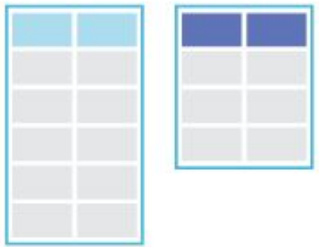


Graph





Document



Column store

Options for NoSQL based managed services

Datastore

Cloud Bigtable

Agenda

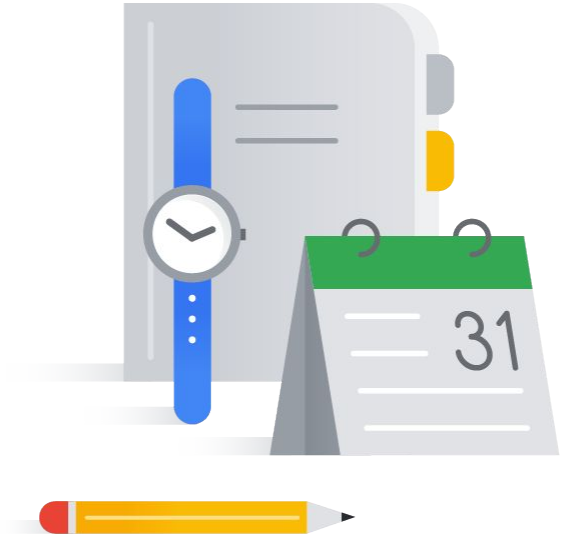
Exploring Cloud SQL

Lab: Cloud SQL for MySQL: Qwik Start

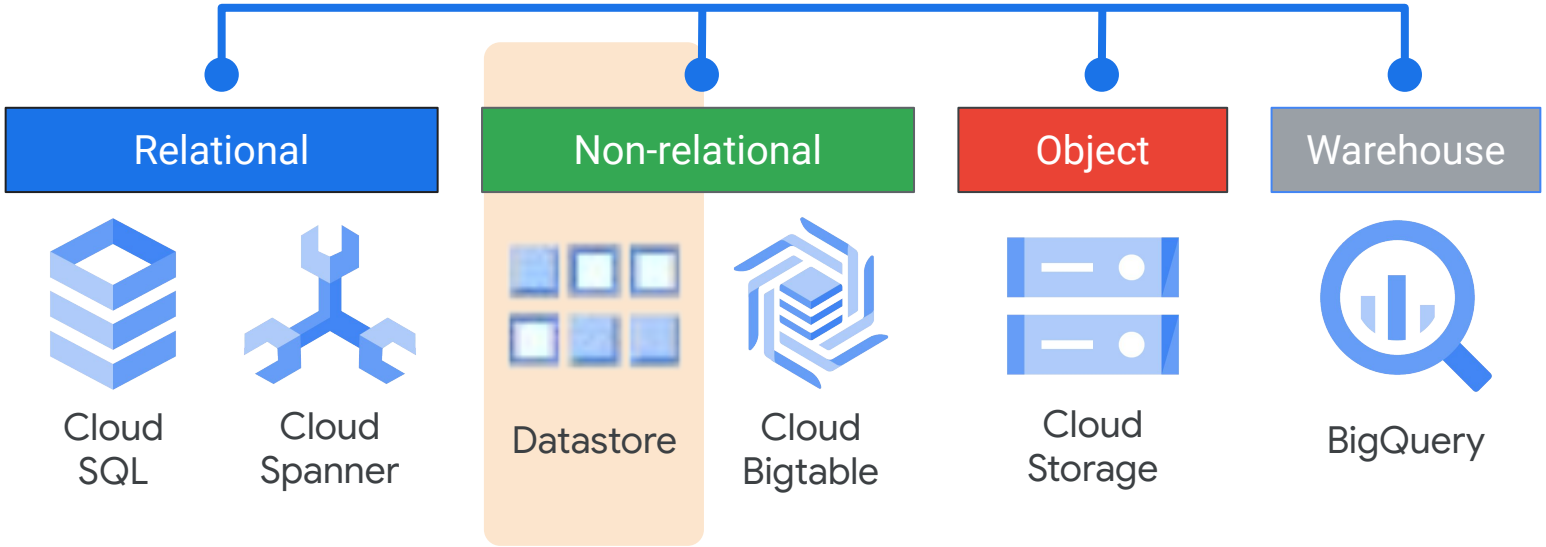
Cloud Spanner as a Managed Service

NoSQL Managed Services Options

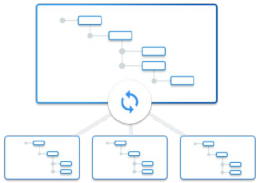
Datastore, a NoSQL Document Store



Datastore in Google Cloud



Datastore is a highly available and durable NoSQL database for low-latency serving of data



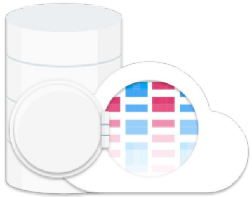
Schema-less

Change your data structure as your app evolves.

Fast and highly scalable

High-speed queries no matter the size of the database.

Seamless scaling.



Fully managed

Instantly provision a scalable and available NoSQL database.

Automatic sharding and replication.

Integrated and secure

RESTful interface makes data accessible by any deployment target.

Serves as an integration point.

Examples of Datastore use cases

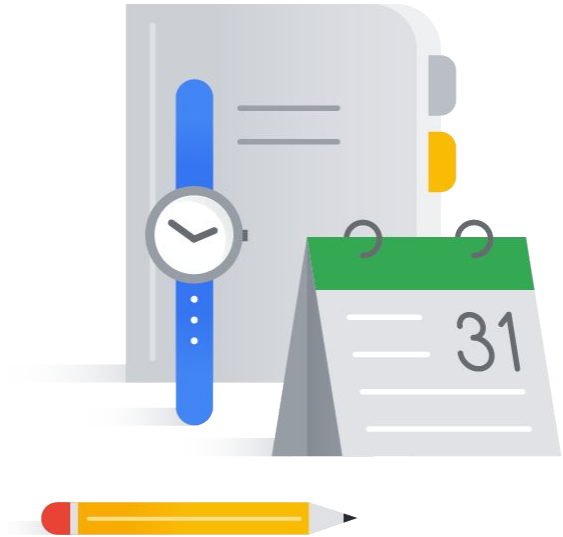
1. User profiles
2. Product catalogues
3. Recording transactions
4. Mobile games

Agenda

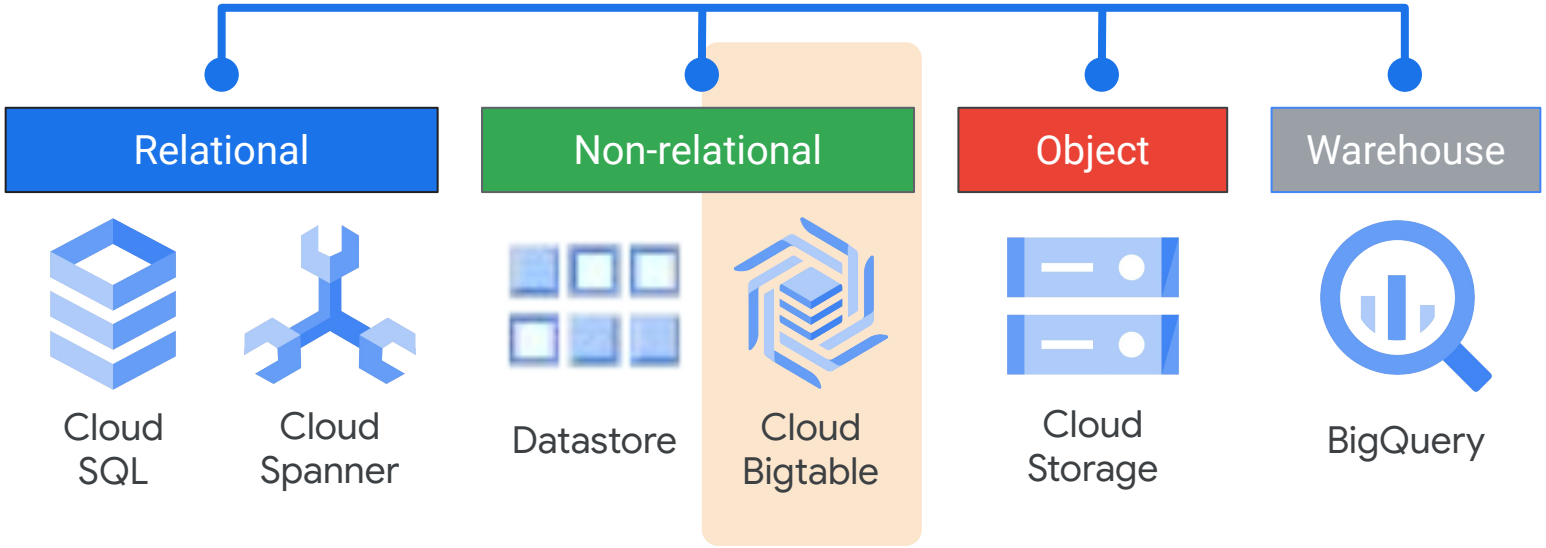
Cloud Bigtable as a NoSQL Option

Quiz

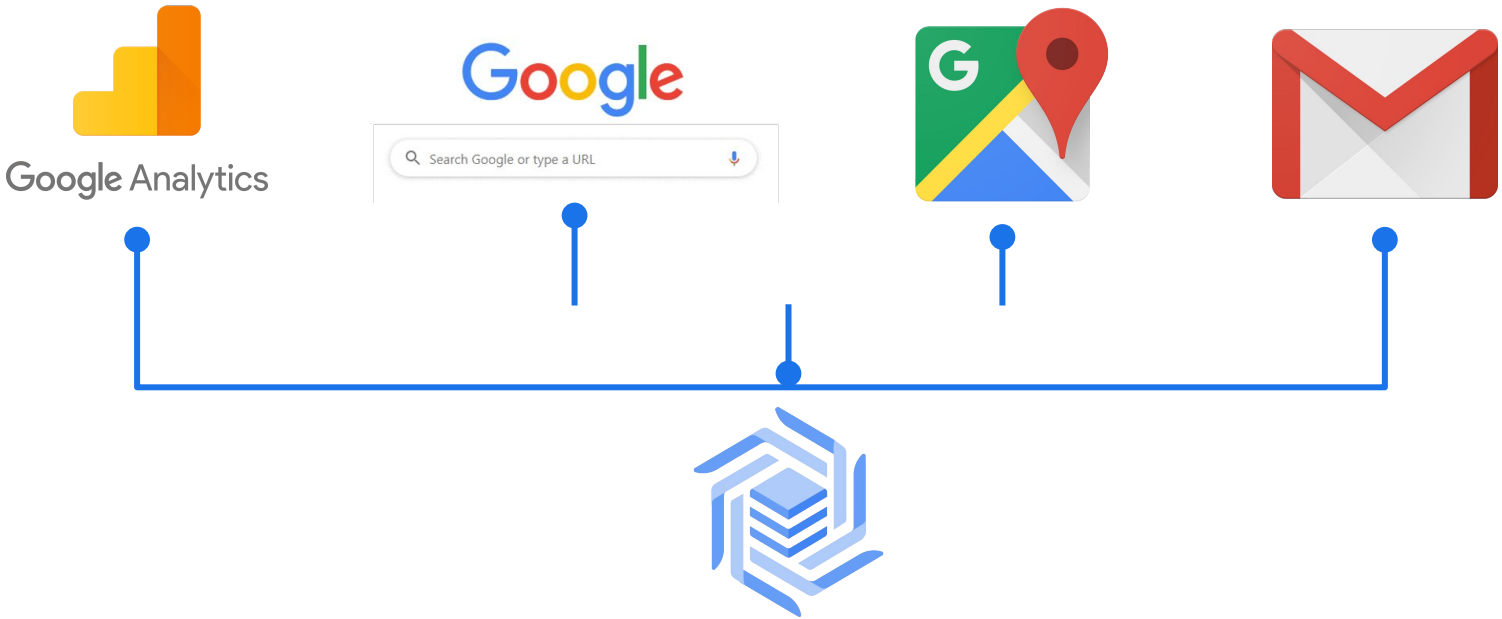
Summary



Cloud Bigtable in Google Cloud



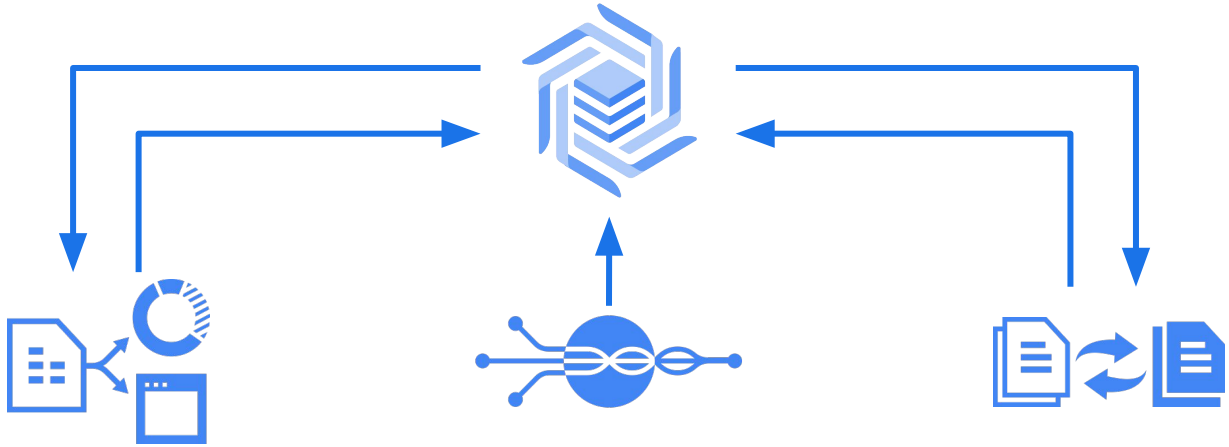
Google uses Cloud Bigtable too!



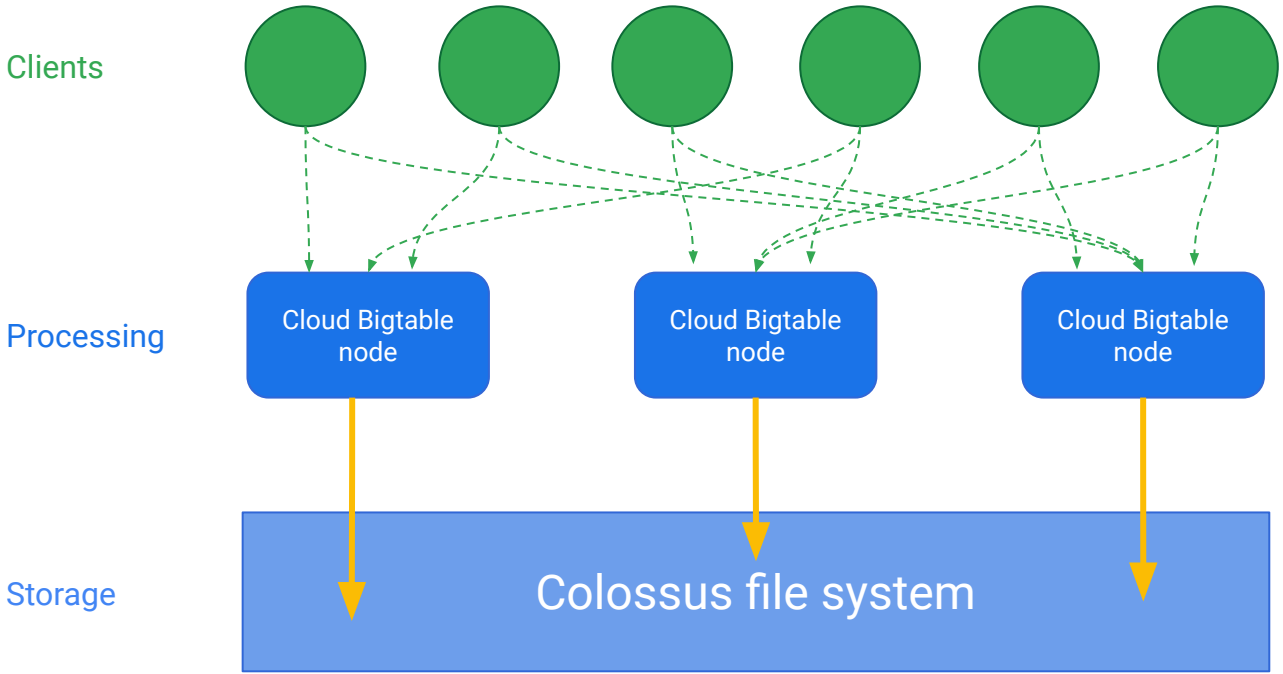
Cloud Bigtable is a fully managed NoSQL database for large analytical and operational workloads

Fast and performant	Seamless scaling and replication	Fully managed	Integrated and secure
High performance under high loads. Faster, more reliable, and more efficient. Low latency	Billions of rows and thousands of columns. No downtime during reconfiguration. Replication adds high availability.	Database configuration and tuning handled by Google. Data backups created for disaster recovery.	Integrated with open-source big data tools for powerful data analysis.

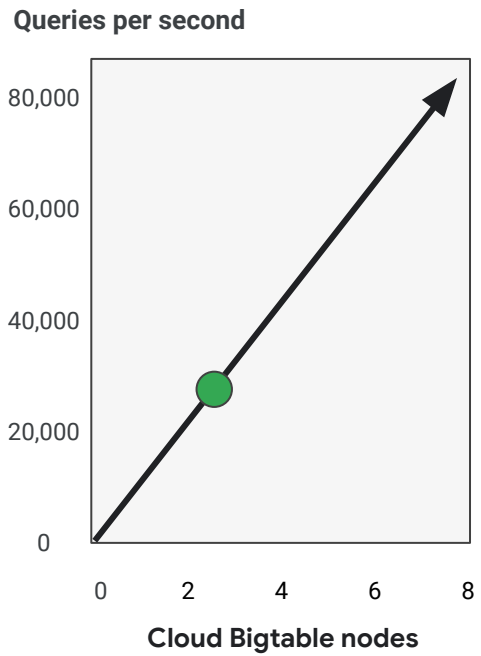
Cloud Bigtable can interact with other Google Cloud services and third-party clients

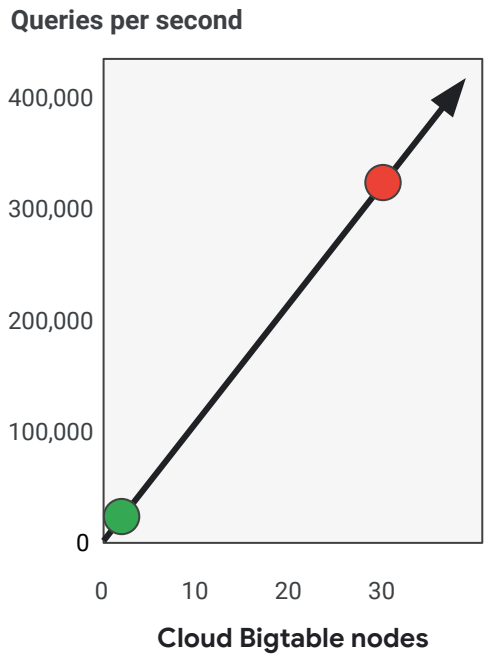


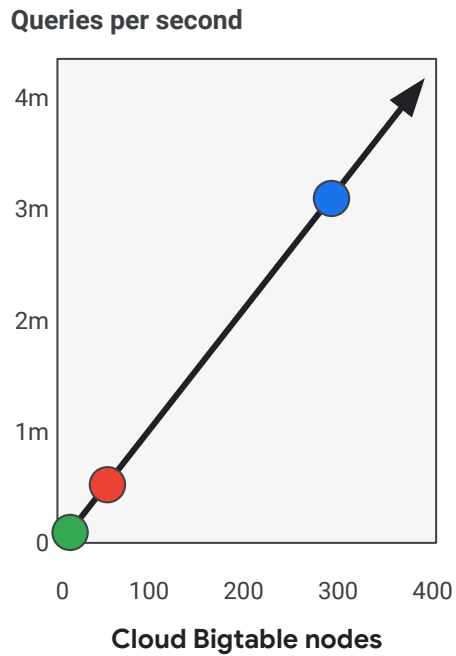
Cloud Bigtable structure



Scaling Cloud Bigtable



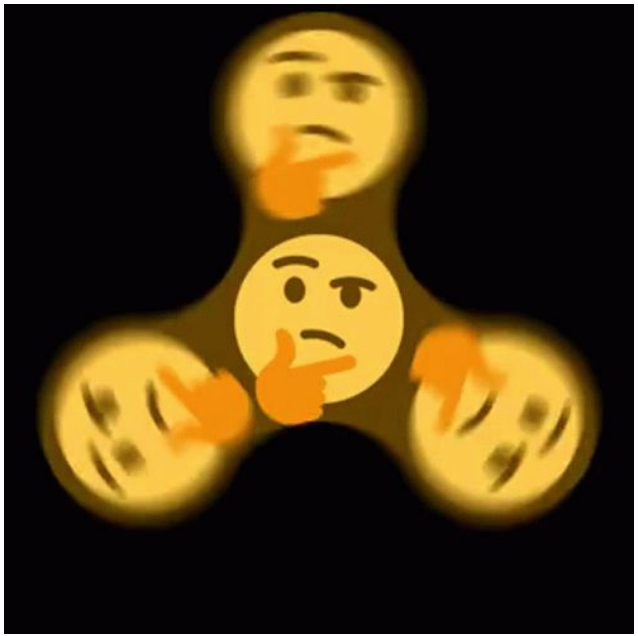




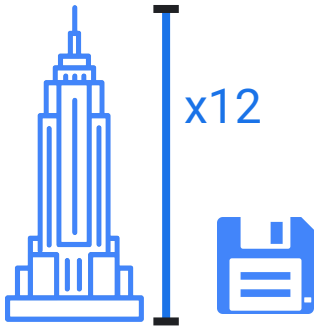
BigQuery / BigLake Codelab

https://codelabs.cs.pdx.edu/labs/C09.1g_bq_bl/index.html?index=..%2F..cs430#0

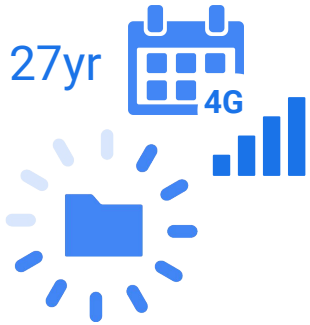
And now, what to do with all this data



How big is a petabyte of data?



A stack of floppy disks higher than 12 Empire State Buildings

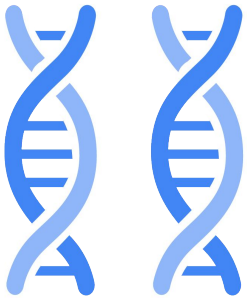


27 years to download over 4G

Every tweet ever tweeted ...

x 50

How small is a petabyte of data?



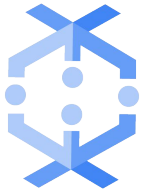
2 micrograms of DNA

1 day's worth of video uploaded to YouTube

Overview of big data managed services

Dataproc

Process big data with Hadoop/Spark



Dataflow

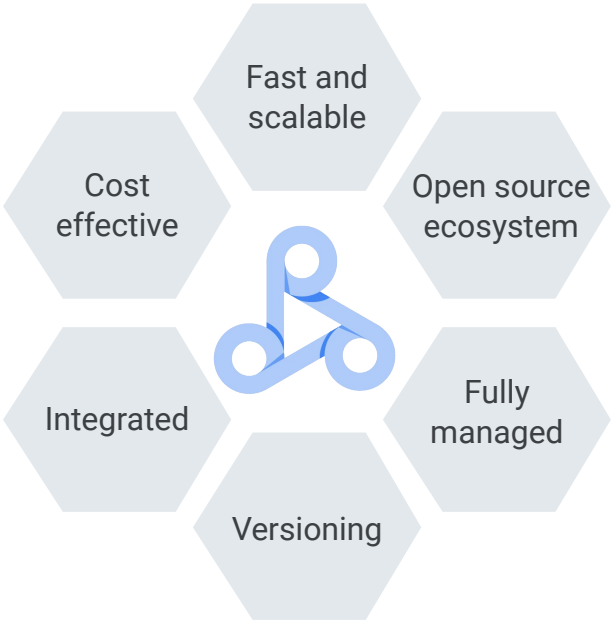
Analyze streaming data in real time

BigQuery

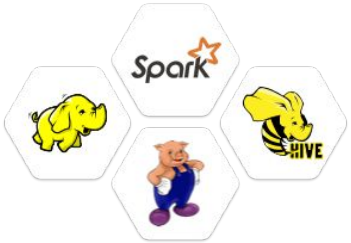
Modernize a data warehouse foundation

Hadoop and Spark are open source technologies that often form the backbone of big data processing

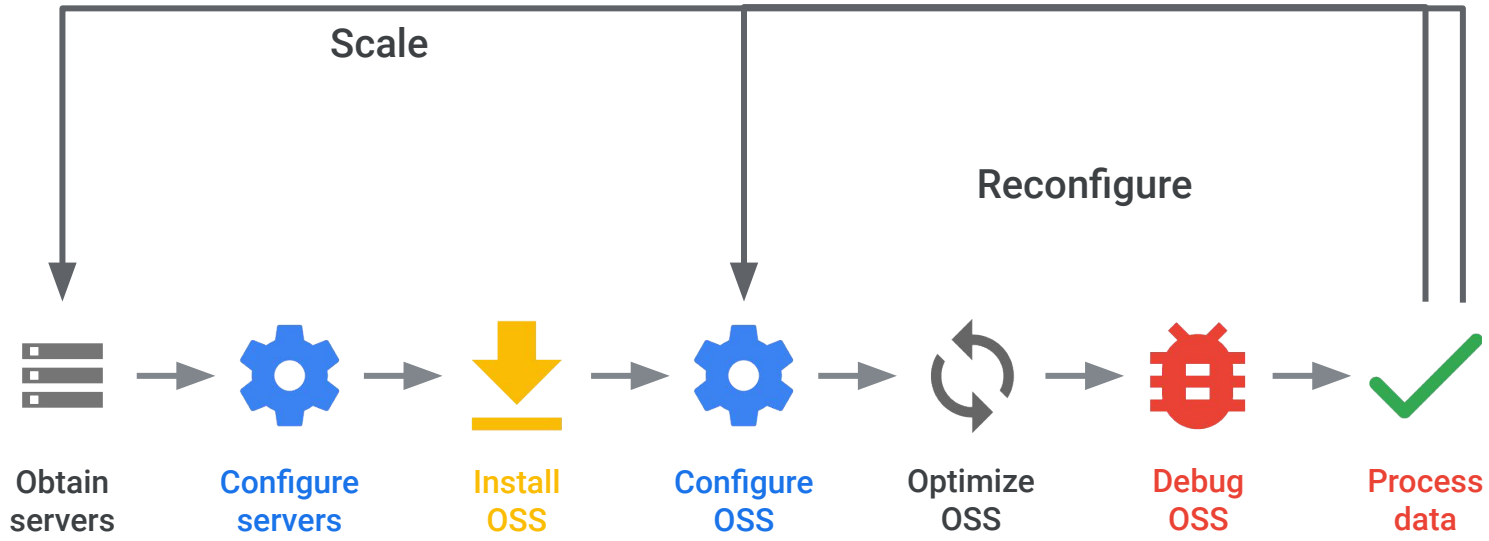
Dataproc is a managed service for batch processing, querying, streaming, and ML



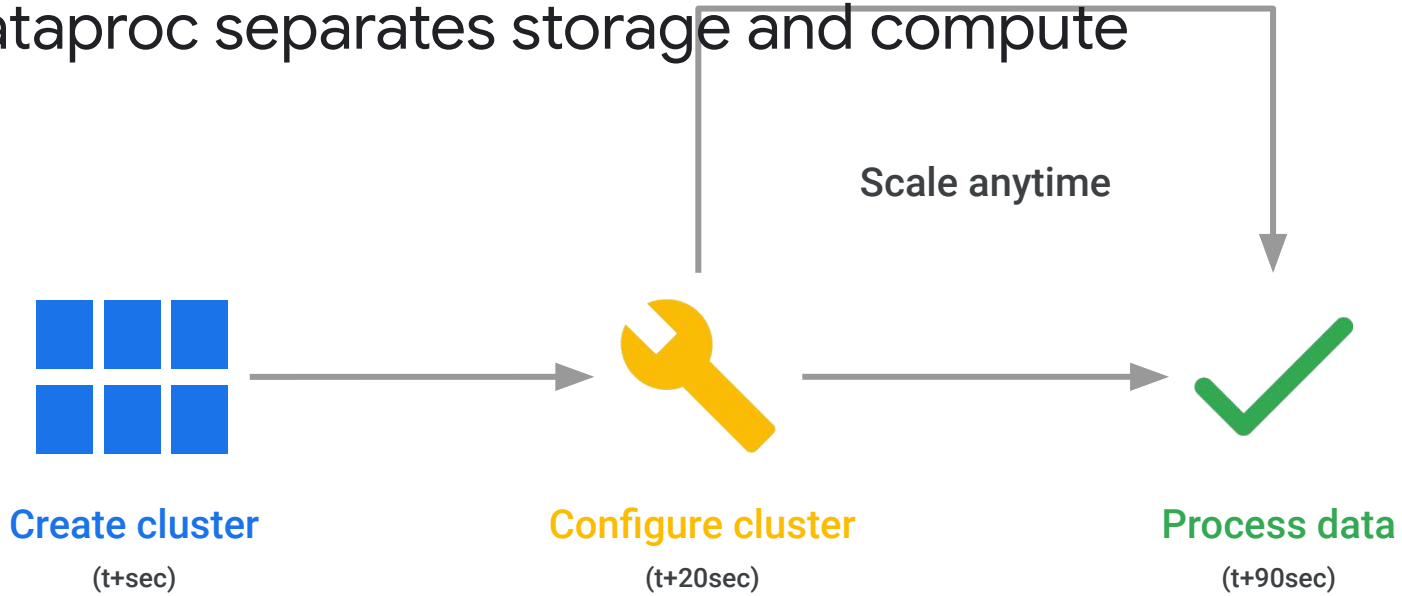
Google Cloud



Typical Spark/Hadoop clusters

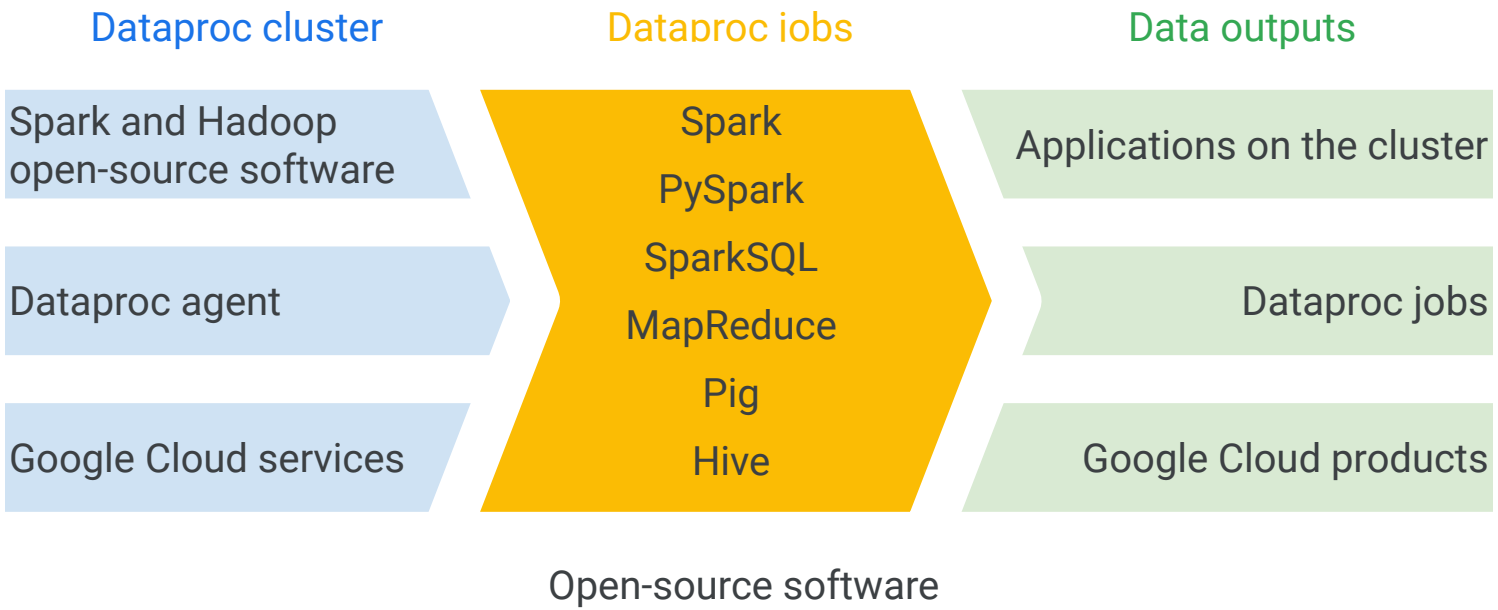


Dataproc separates storage and compute

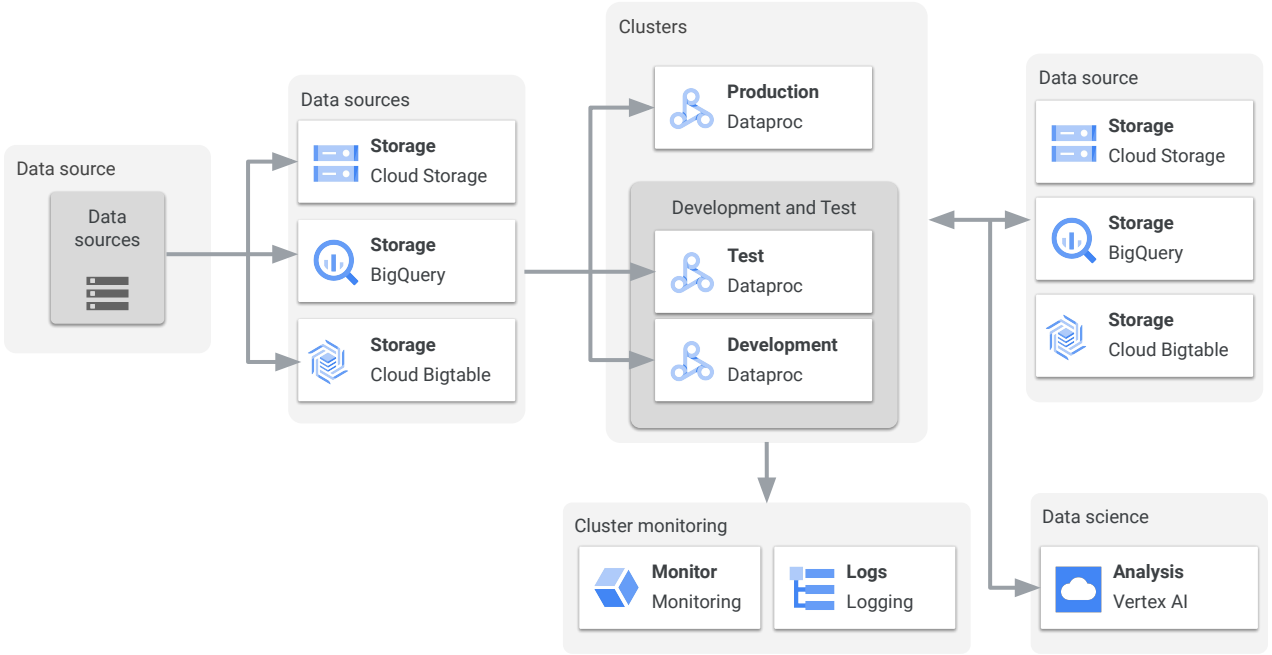


hdfs:// gs://

Hadoop and Spark jobs and workflows



No management or maintenance required!

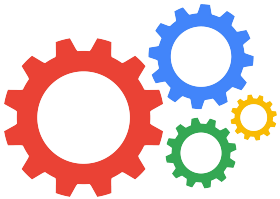


Dataproc can help with log processing

The need

Large volumes of data from several sources are aggregated and loaded into databases so metrics can be gathered for daily reporting, management dashboards, and analysis.

A dedicated on-premises cluster is currently used to store and process the logs with MapReduce.

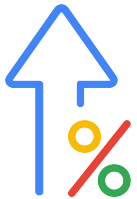


The solution

Cloud Storage provides a low-cost storage option.

An ephemeral Dataproc cluster can be created in less than 2 mins.

Data is processed with existing MapReduce.



The value

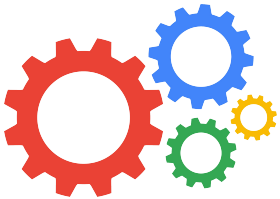
Saves money and reduces complexity.

Dataproc can help with ad-hoc data analysis

The need

Analysts are using Spark Shell but are concerned about increase in usage.

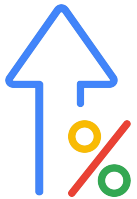
Unsure on how to scale their cluster, which is running in standalone mode.



The solution

Creates clusters that scale for speed and mitigate failure.

Can use web interface, Cloud SDK, or native Spark Shell via SSH.



The value

Unlocks the cloud without technical complexity.

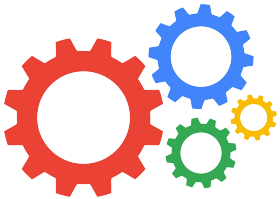
Complex computations take seconds, not hours.

Dataproc can help with machine learning

The need

Spark Machine Learning Libraries (MLlib) are used to run classification algorithms on large datasets.

There is a reliance on cloud based machines to install and customize Spark.

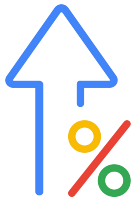


The solution

Spark and MLlib can be installed on any Dataproc cluster.

Customizations can be applied to clusters via initialization actions.

Use Cloud Monitoring to monitor workflows.



The value

Resources can focus on data, not cluster creation and management.

Integration with Google Cloud unlocks new Spark features.

Agenda

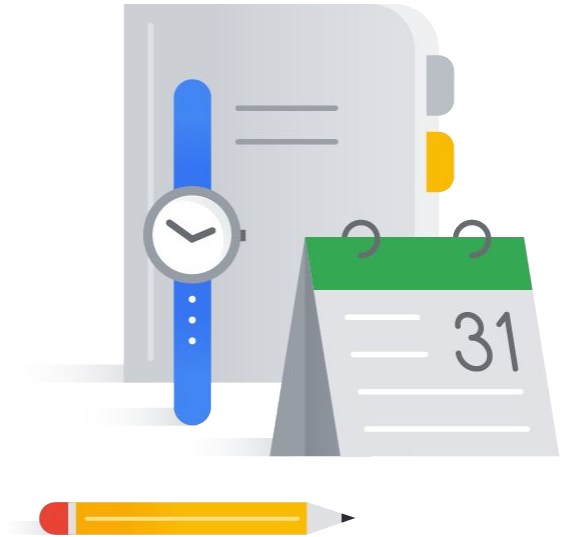
Introduction to Big Data Managed Services in the Cloud

Leverage Big Data Operations with Dataproc

Lab: Dataproc: Qwik Start: Console

Lab: Dataproc: Qwik Start: Command Line

Build Extract, Transform, and Load Pipelines using Dataflow



Lab Intro

Dataproc: Qwik Start - Console

Create a Dataproc cluster, run a simple Apache Spark job in the cluster, and modify the number of workers in the cluster using the Cloud Console.

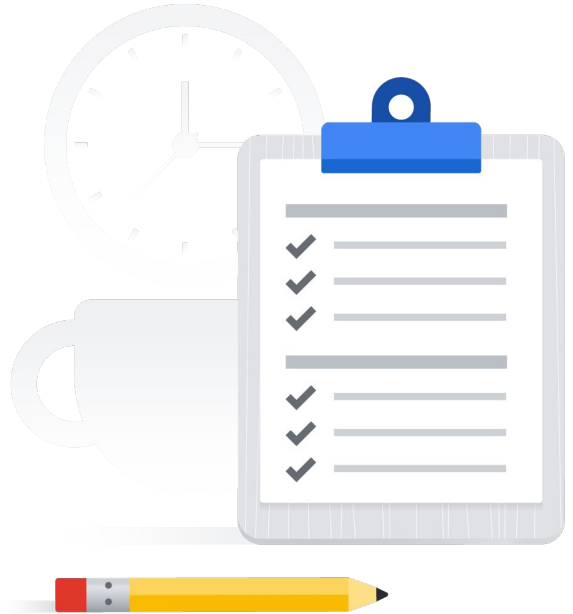
The lab can be found here.

Lab objectives

Create a cluster.

Submit a job.

View the job output.



Lab Intro

Introduction to Dataproc: Hadoop and Spark on Google Cloud (Alternative)

Create a Dataproc cluster, submit a Spark job, and shut down your cluster.

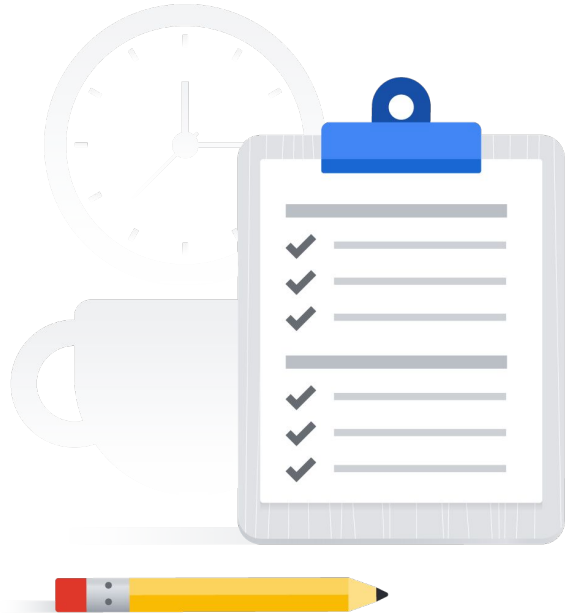
The lab can be found here.

Lab objectives

Create a Dataproc cluster.

Submit a Spark job to the cluster.

Shut down the cluster.



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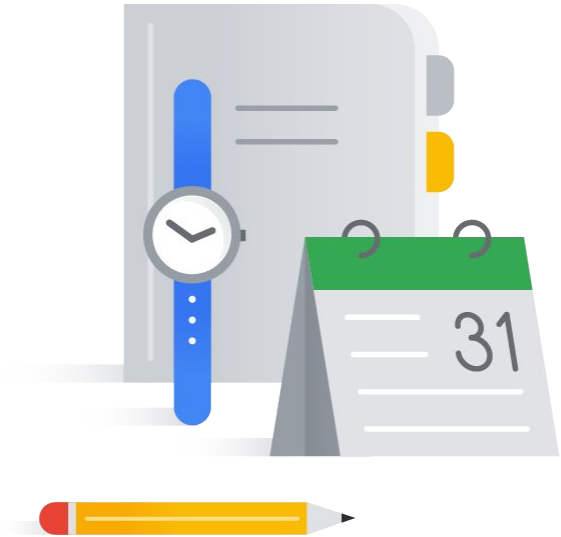


Lab Intro

Dataproc: Qwik Start - Command Line

Create a Dataproc cluster, run a simple Apache Spark job in the cluster, and modify the number of workers in the cluster using gcloud on Google Cloud.

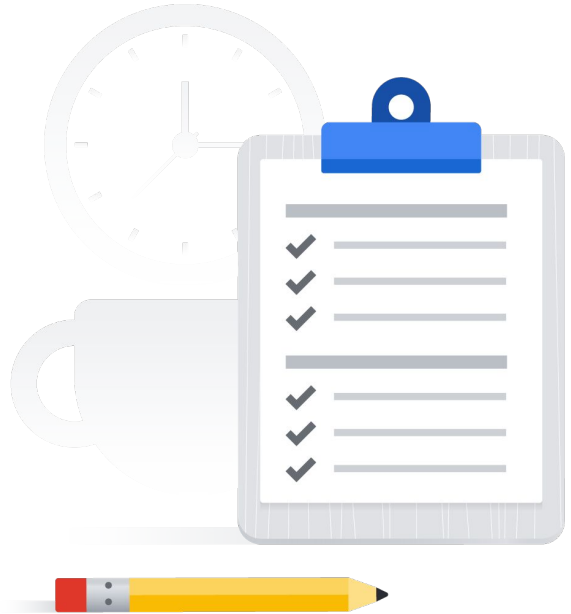
The lab can be found here.

Lab objectives

Create a cluster.

Submit a job.

Update a cluster.



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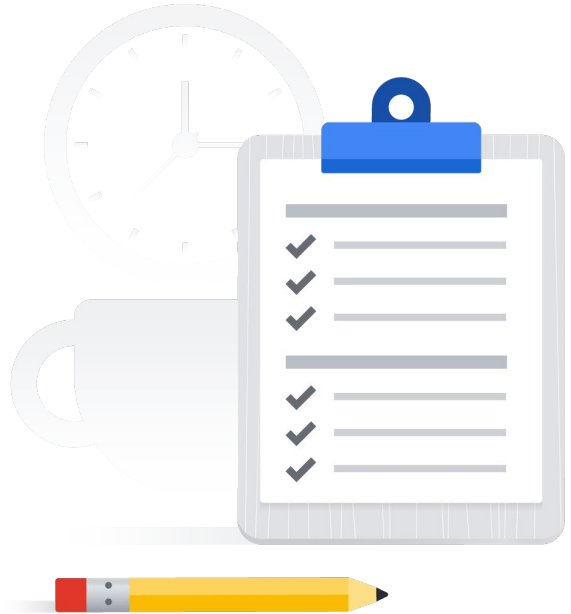

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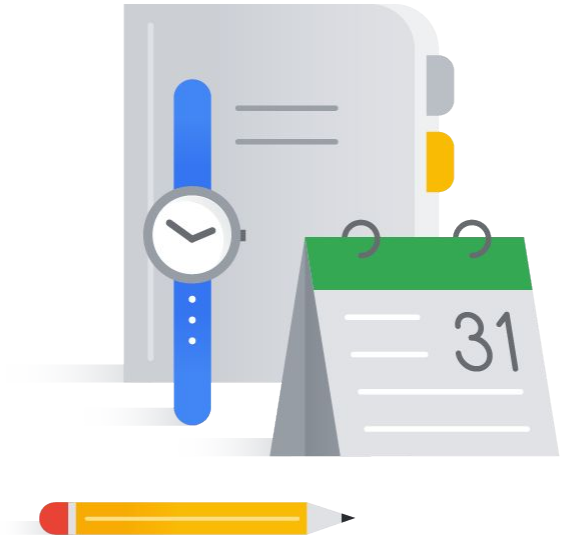
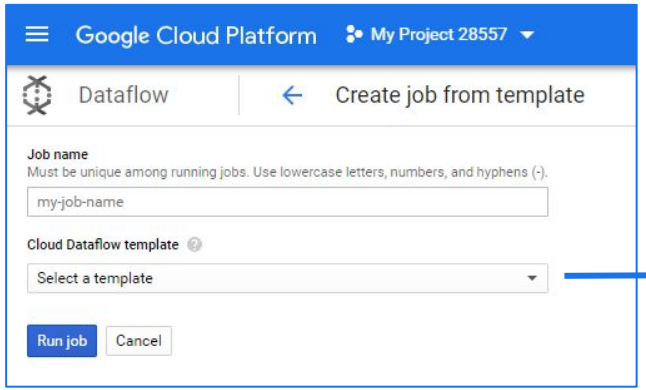
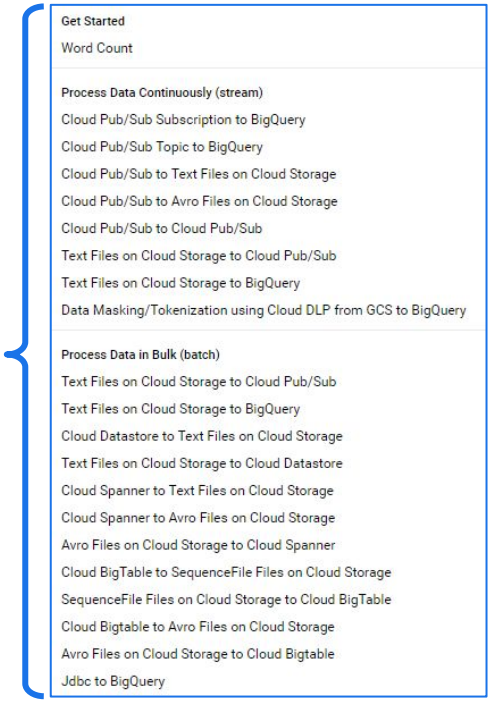


Dataflow offers simplified stream and batch data processing

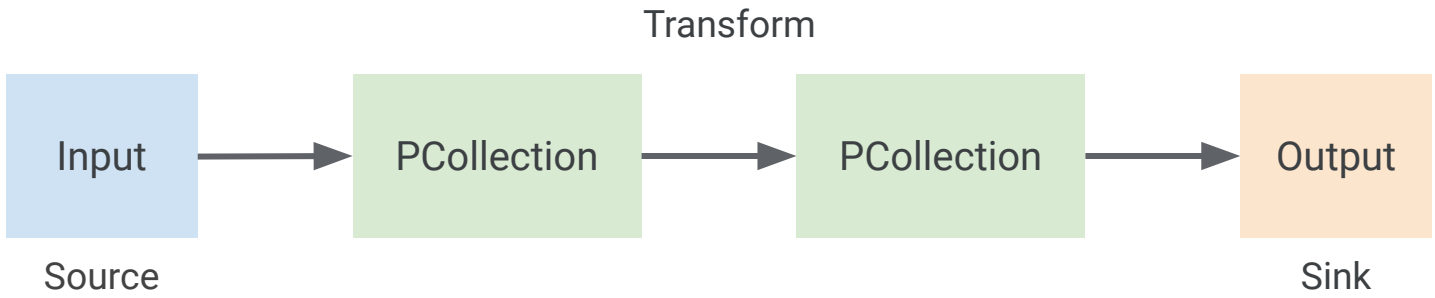
- Unified programming model
- Fully-managed service
- Integrated

Dataflow templates enable the rapid deployment of standard job types



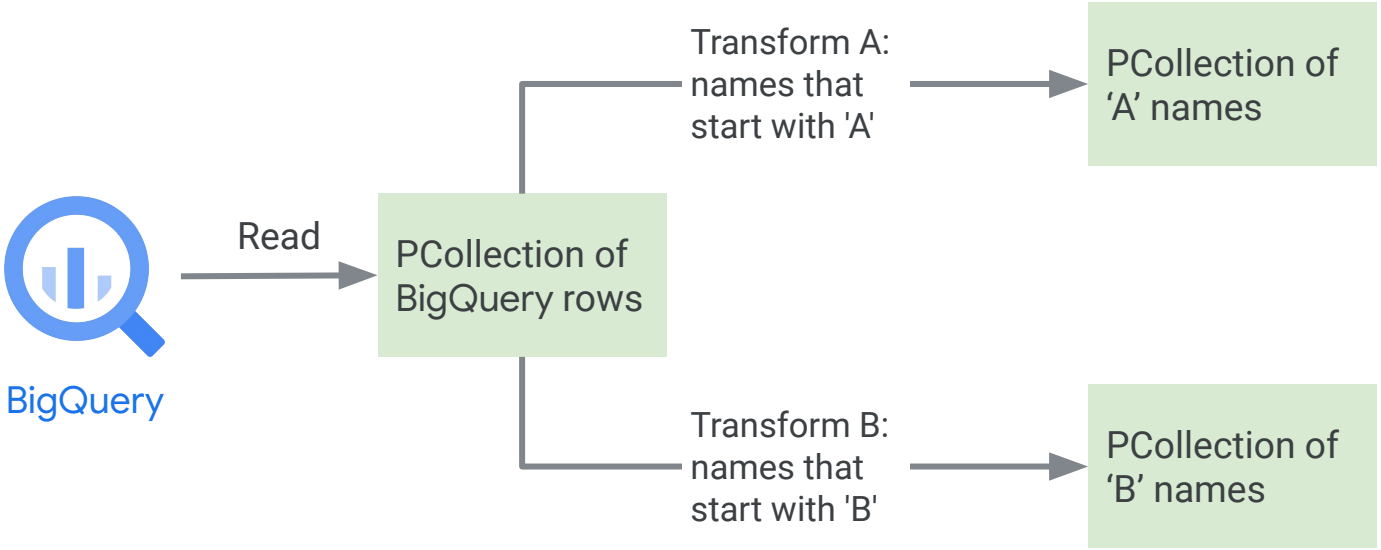


Understanding pipelines

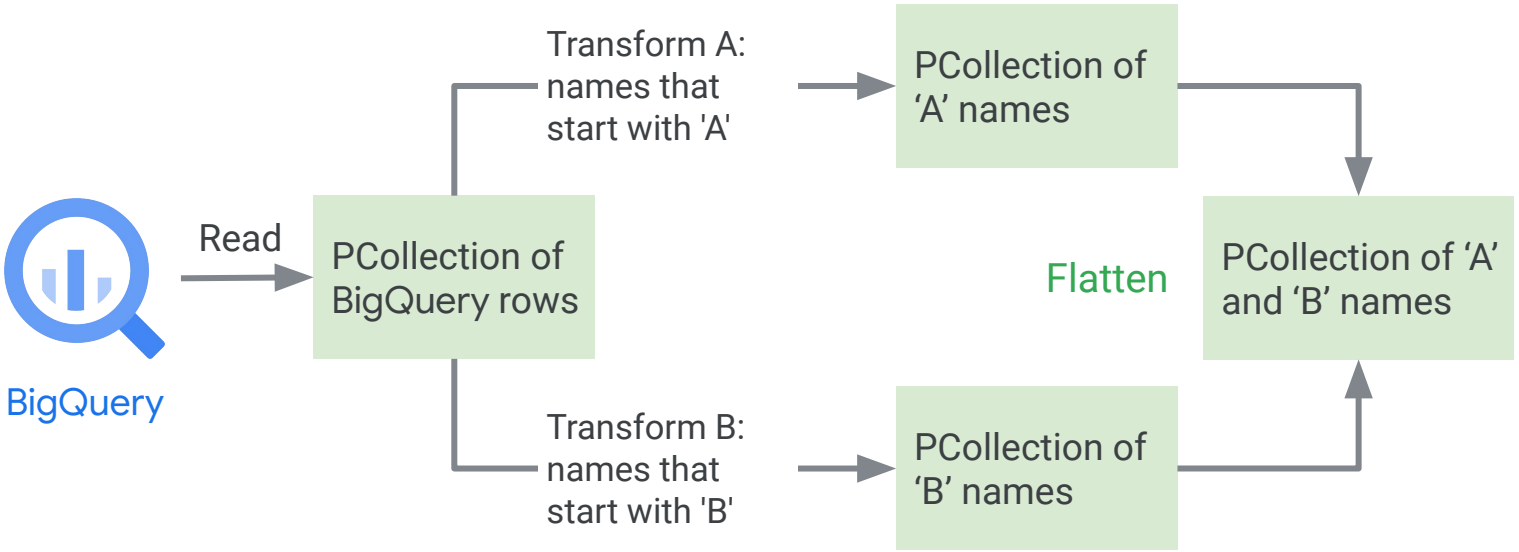


Simple pipeline example

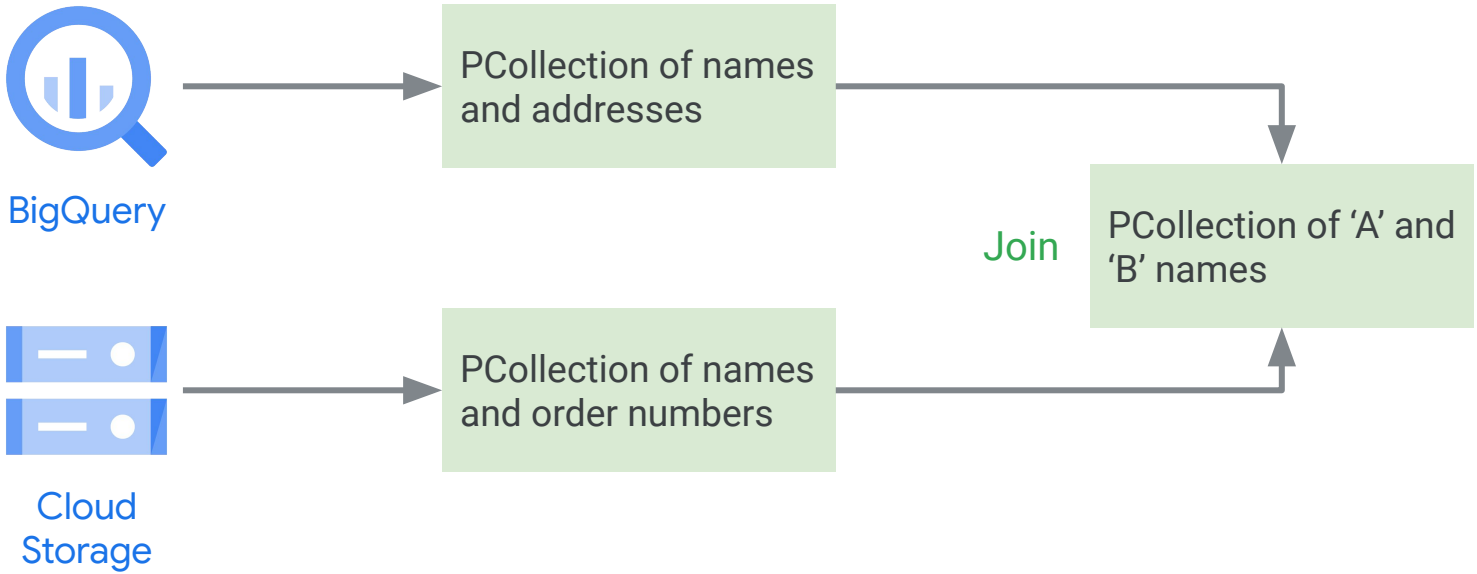
A multiple transform pipeline extract



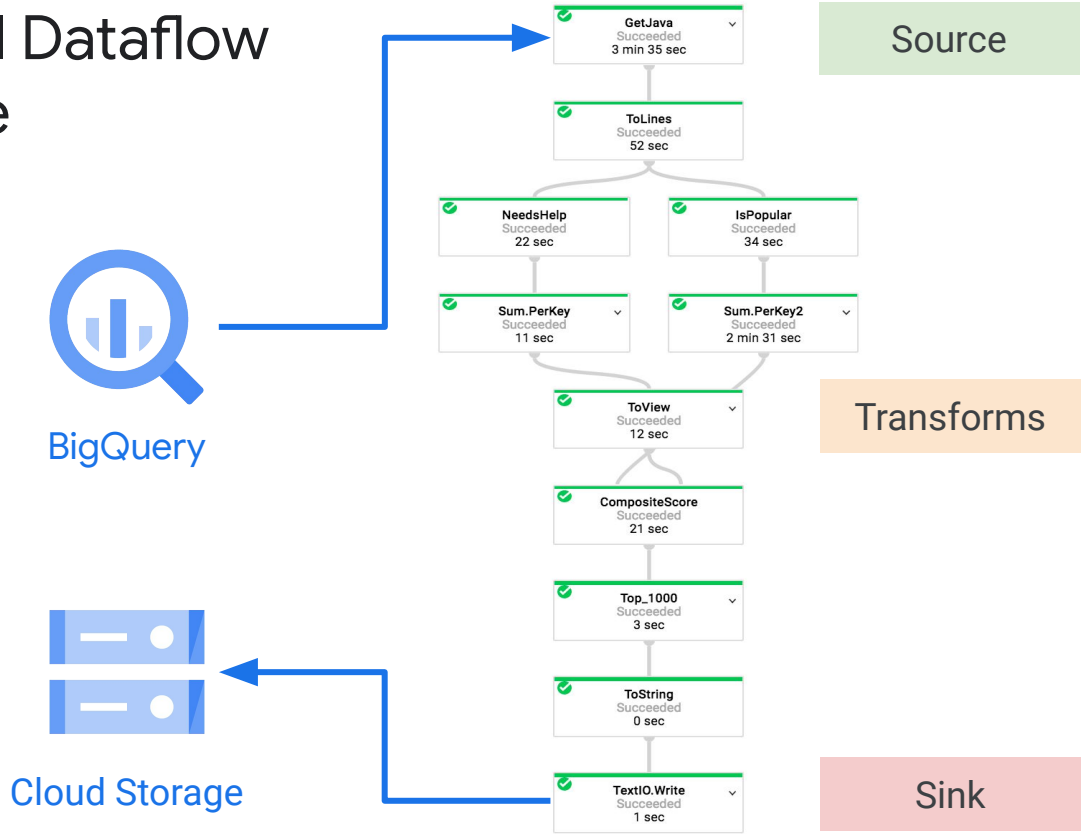
A merge pipeline extract



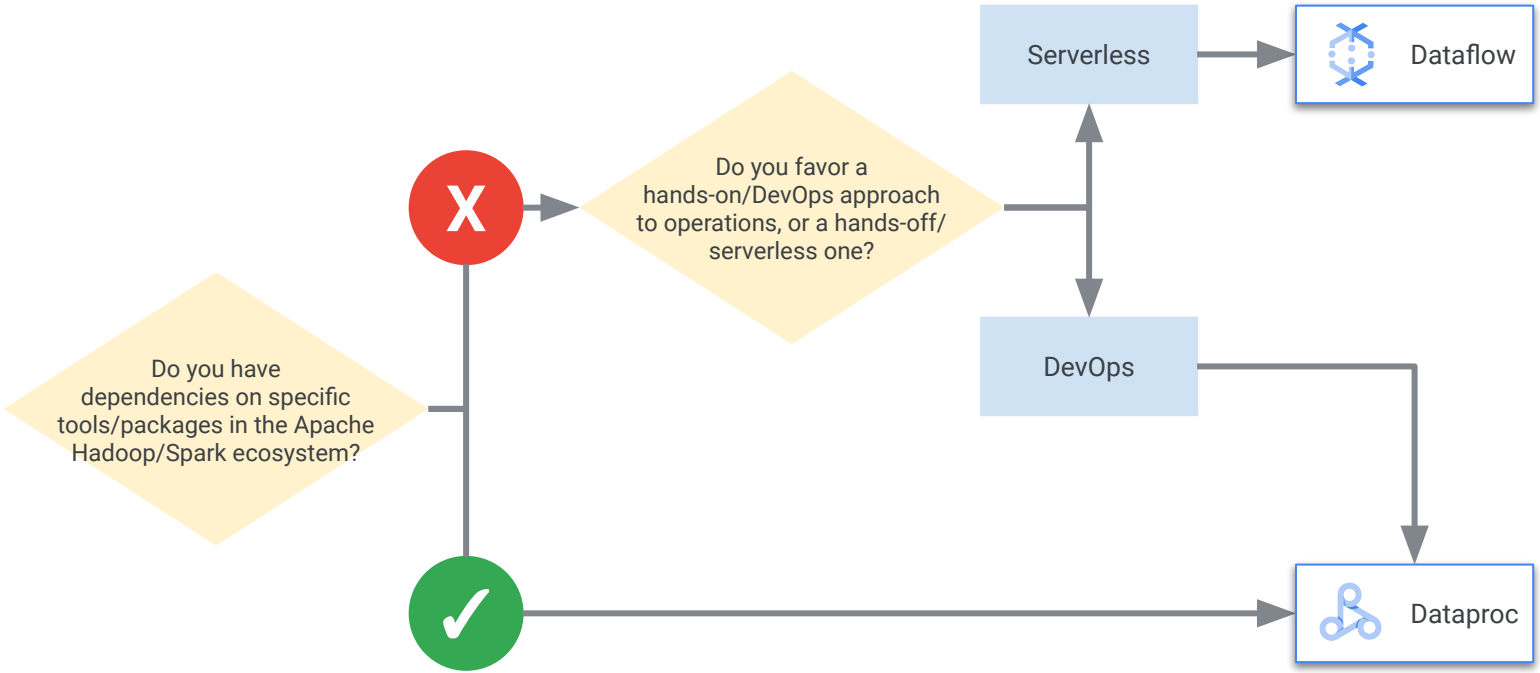
A multiple input pipeline



A simple but real Dataflow pipeline example



Dataproc versus Dataflow



Agenda

Lab: Dataflow: Qwik Start - Templates

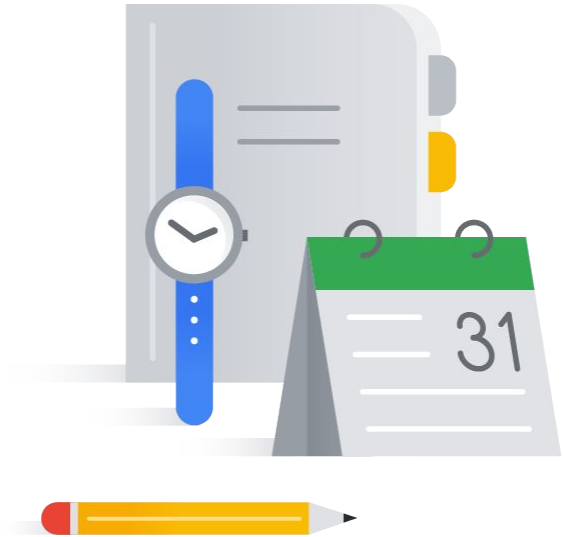
Lab: Dataflow: Qwik Start - Python

BigQuery, Google's Enterprise Data Warehouse

Lab: Dataprep: Qwik Start

Quiz

Summary



Lab Intro

Dataflow: Qwik Start - Templates

Create a streaming pipeline using a Google-provided Dataflow template.

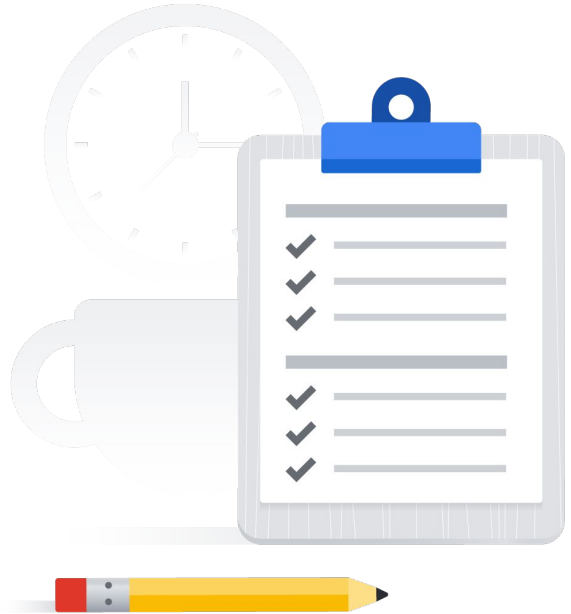
You can find the lab here.

Lab objectives

Create a BigQuery dataset and table using Cloud Shell and/or the Cloud Console.

Run the pipeline.

Submit a query.



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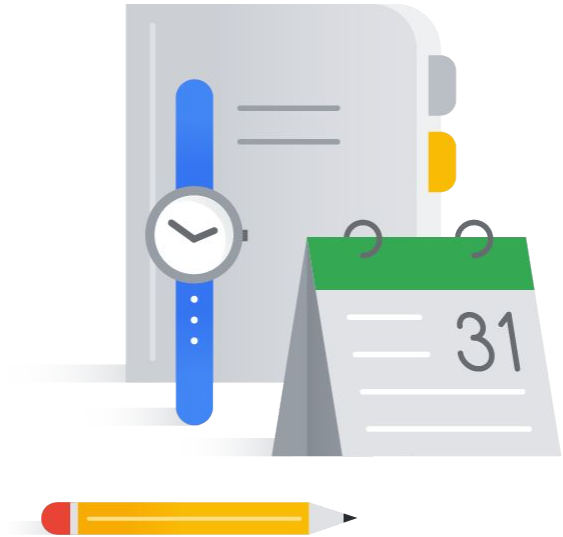
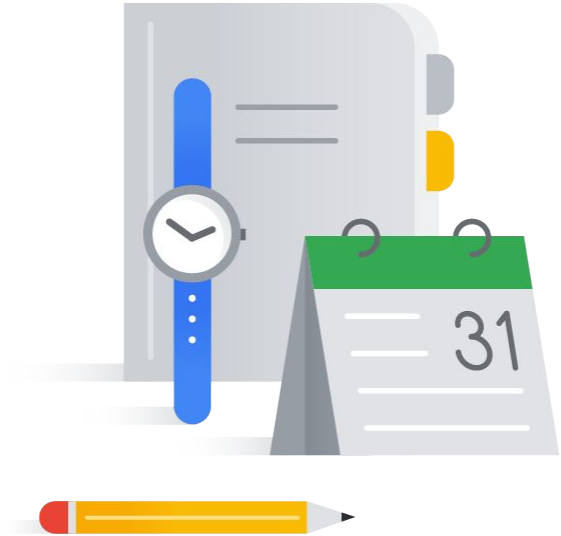


Lab!

Serverless Data Processing with Dataflow - Writing an ETL Pipeline using Apache Beam and Dataflow (Python)



https://www.cloudskillsboost.google/focuses/64780?catalog_rank=%7B%22rank%22%3A3%2C%22num_filters%22%3A0%2C%22has_search%22%3Atrue%7D&parent=catalog&search_id=38607186

Lab Intro

Dataflow: Qwik Start - Python

Set up a Python development environment, get the Dataflow SDK for Python, and run an example pipeline using the Cloud Console.

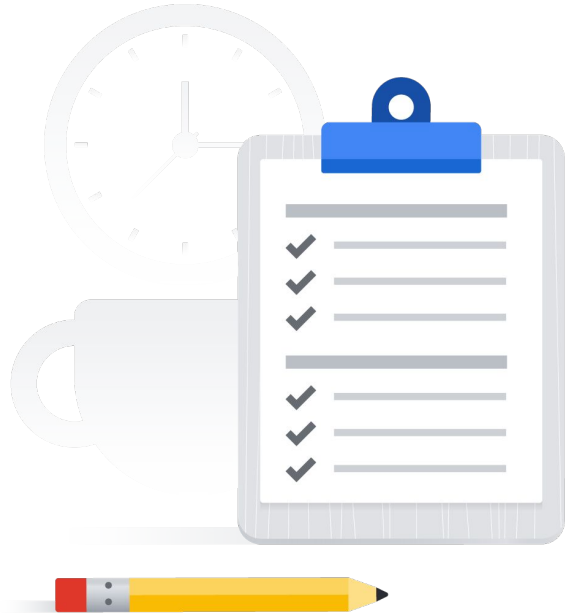
~~You can find the lab here.~~

Lab objectives

Set up a Python development environment.

Get the Dataflow SDK for Python.

Run an example pipeline using the Cloud Console.

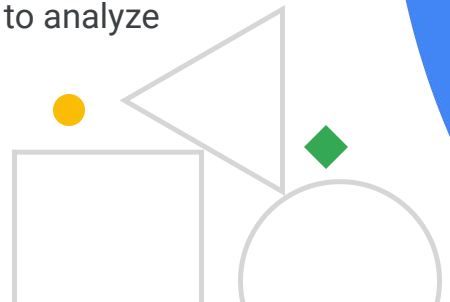


Lab Intro

Processing Data with Dataflow (Alternative)

Process a set of text files from a real-time real world historical dataset using Python and Dataflow, and use BigQuery to analyze some features.

You can find the lab here.



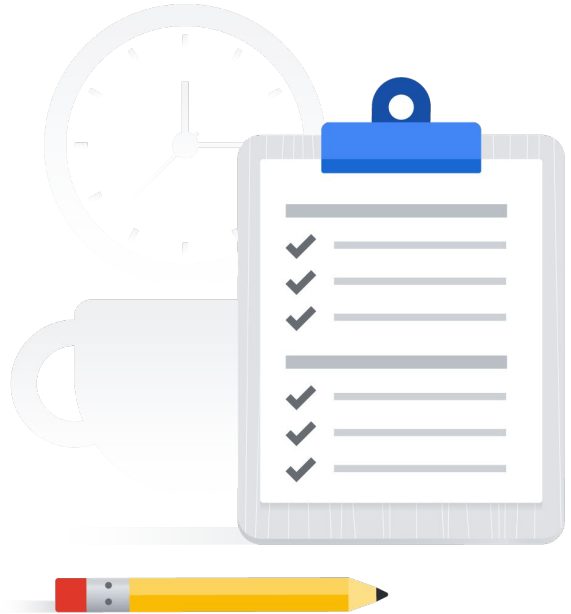
Lab objectives

Configure a Python application to create a simulated real-time data stream from historical data.

Use Apache Beam locally to test Dataflow locally.

Use Apache Beam to process data using Dataflow to create a simulated real-time data set.

Query the simulated real-time data stream using BigQuery.



Agenda

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BigQuery, Google's Enterprise Data Warehouse

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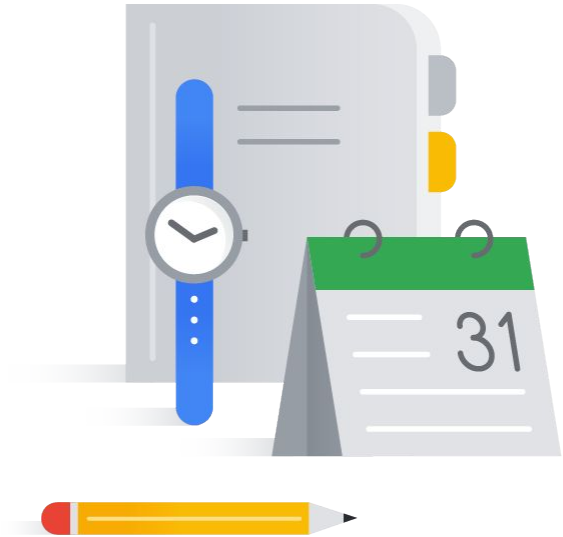
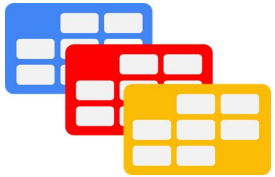


https://www.youtube.com/watch?v=eyBK9nj-7AA

BigQuery is Google's data warehouse solution

Data warehouse

BigQuery replaces a typical data warehouse hardware setup

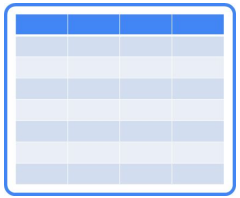


Data mart

BigQuery organizes data tables into units called datasets

Data lake

BigQuery defines schemas and issues queries directly on external data sources



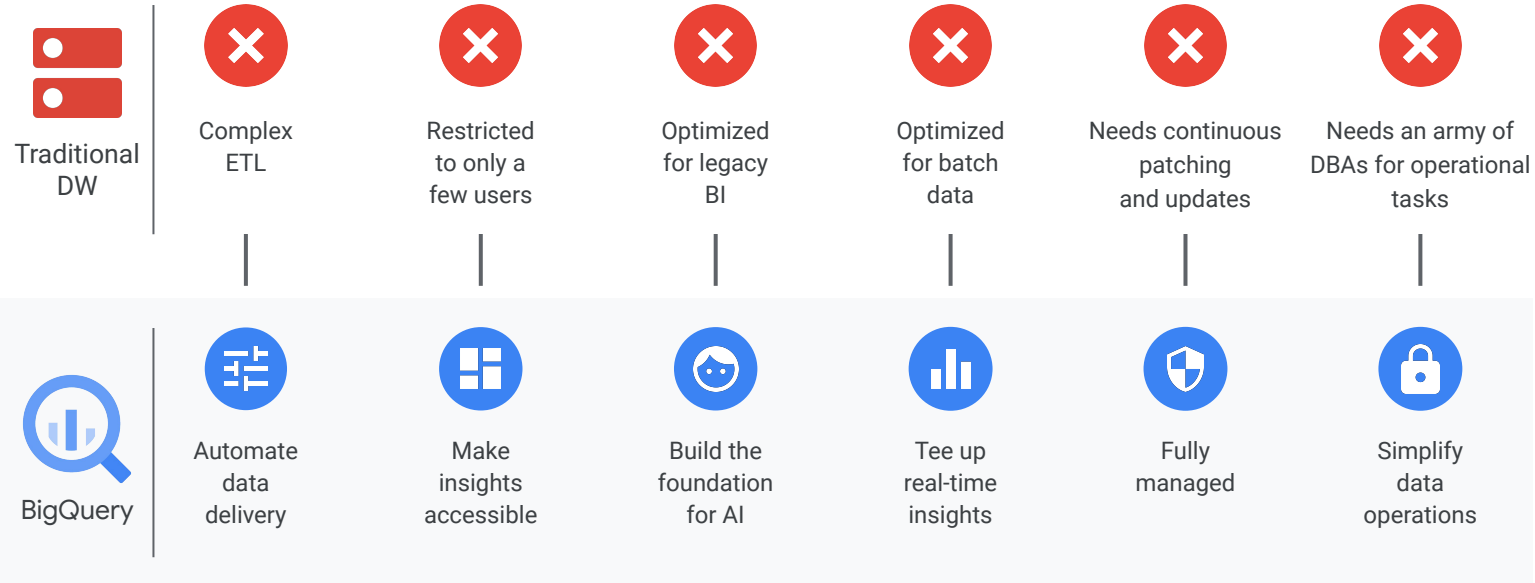
Tables and views

Function the same way as in a traditional data warehouse

Grants

Cloud IAM grants permission to perform specific actions

BigQuery is a modern data warehouse that changes the conventional mode of data warehousing



BigQuery ML enables users to create and execute ML models in BigQuery using standard SQL queries

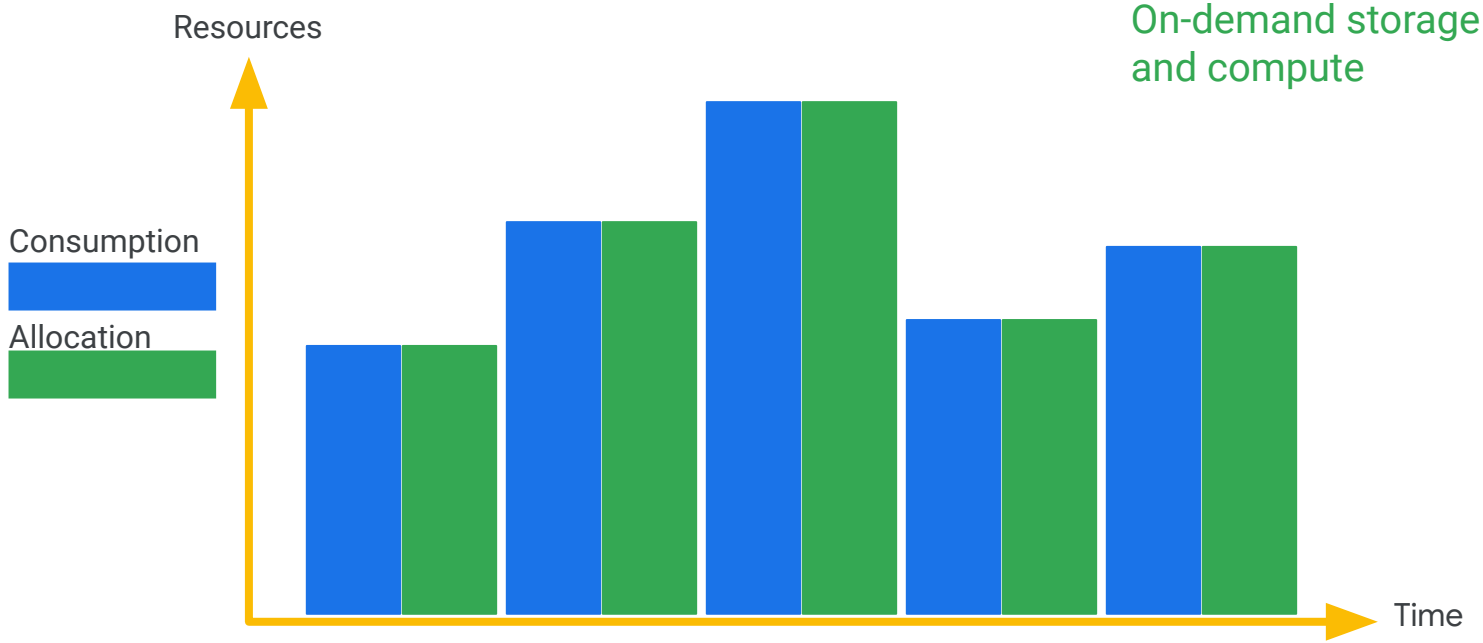
1. Execute ML initiatives without moving data from BigQuery.
2. Iterate on models in SQL in BigQuery to increase development speed.
3. Automate common ML tasks and hyperparameter tuning.

BigQuery is a fully-managed service

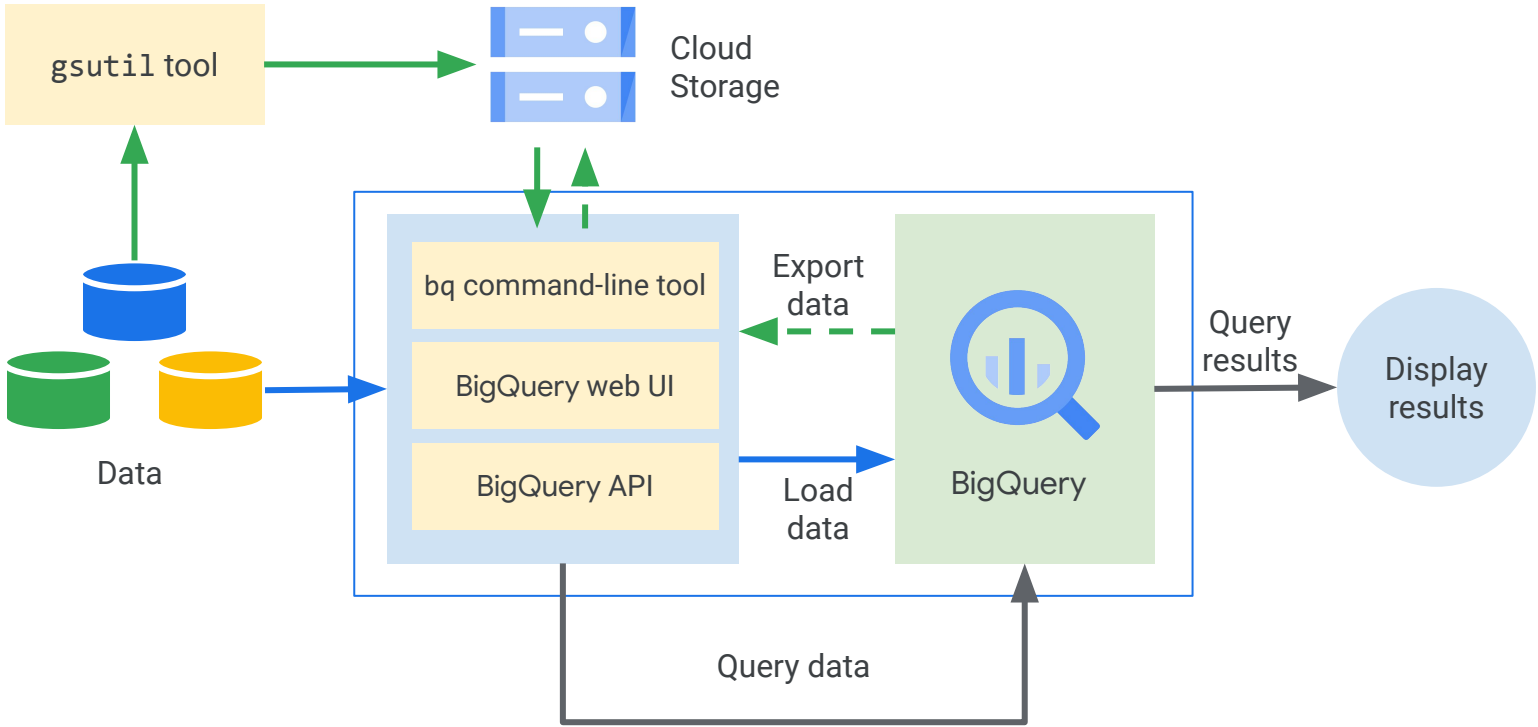
- Data aging
- Storage management
- Fault recovery
- Query engine optimization
- Hardware
- Updates

Free up real people-hours by not having to worry about common tasks.

You don't need to provision resources before using BigQuery



Loading data into BigQuery



There are various ways that you can connect to BigQuery and analyze the data

tableau
CHARTIO
Anodot
SAP® Analytics Cloud
bime by zendesk
Yellowfin
ZOOMDATA
iCharts
OWOX
atscale
MicroStrategy
Dundas BI
MODE
DOMO
IBM Cognos Analytics
Qlik
re:dash

Data Analysis and Visualization Partners

BQ examples

BigQuery - Google Cloud Big Data → GitHub queries

```
#standardSQL
SELECT SUM(copies) FROM `bigquery-public-data.github_repos.sample_contents`
WHERE NOT binary AND content LIKE '%This should never happen%'
```

```
#standardSQL
SELECT SUM(copies) FROM `bigquery-public-data.github_repos.sample_contents`
WHERE NOT binary AND (content LIKE '%This should never happen%' OR content
LIKE '%FIXME%' OR content LIKE '%TODO%')
```

Lab Intro

Dataprep: Qwik Start

Use Dataprep to manipulate a dataset. You import datasets, correct mismatched data, transform data, and join data.

You can find the lab here.