
Big Data and Machine
Learning in the Cloud

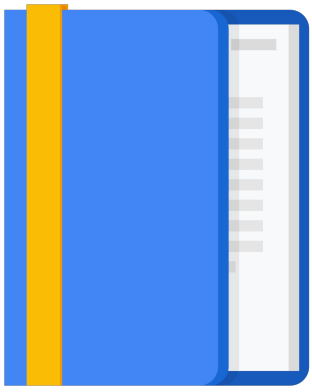
Agenda

Google Cloud Big Data Platform

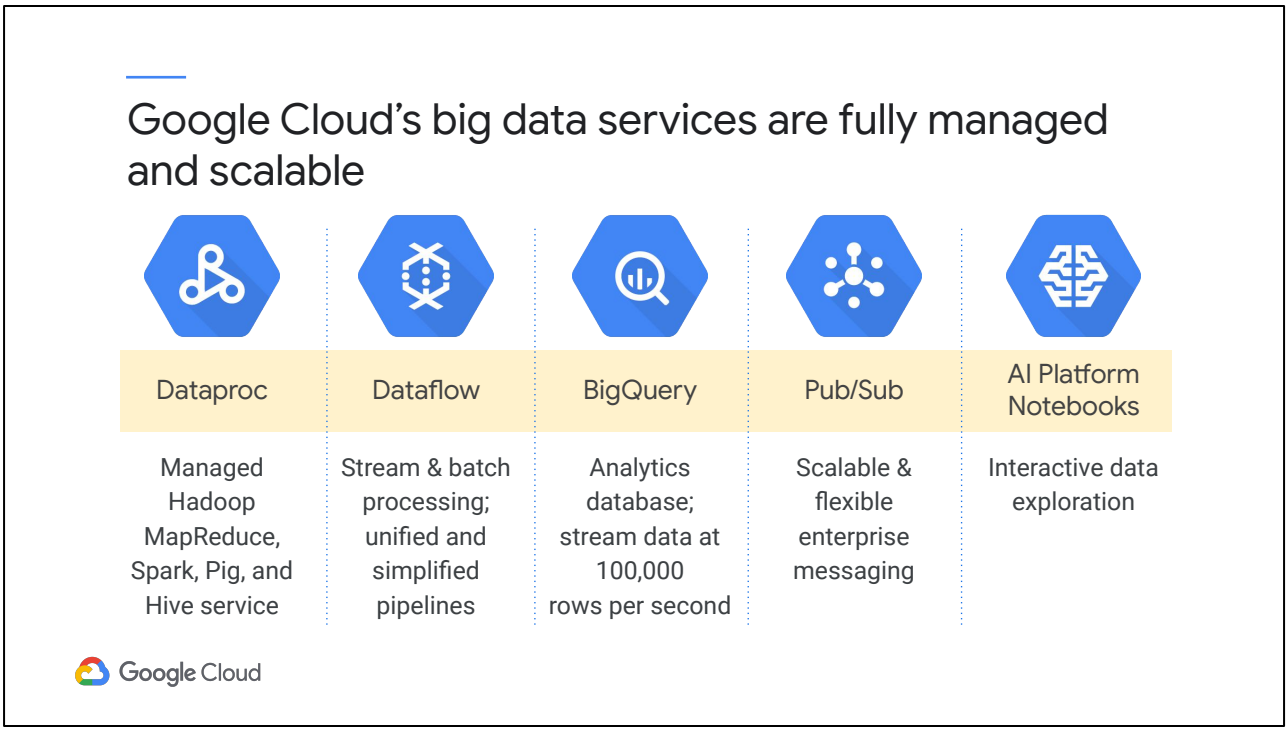
Machine Learning in the Cloud

Quiz and Lab

Resources



Google Cloud



Google Cloud Big Data solutions are designed to help you transform your business and user experiences with meaningful data insights. It is an integrated, serverless platform. “Serverless” means you don’t have to provision compute instances to run your jobs. The services are fully managed, and you pay only for the resources you consume. The platform is “integrated” so Google Cloud data services work together to help you create custom solutions.

Dataproc is managed Hadoop

- Fast, easy, managed way to run Hadoop and Spark/Hive/Pig on Google Cloud.
- Create clusters in 90 seconds or less on average.
- Scale clusters up and down even when jobs are running.

Google Cloud

Apache Hadoop is an open-source framework for big data. It is based on the MapReduce programming model, which Google invented and published. The MapReduce model, at its simplest, means that one function -- traditionally called the “map” function -- runs in parallel across a massive dataset to produce intermediate results; and another function -- traditionally called the “reduce” function -- builds a final result set based on all those intermediate results. The term “Hadoop” is often used informally to encompass Apache Hadoop itself and related projects, such as Apache Spark, Apache Pig, and Apache Hive.

Dataproc is a fast, easy, managed way to run Hadoop, Spark, Hive, and Pig on Google Cloud. All you have to do is to request a Hadoop cluster. It will be built for you in 90 seconds or less, on top of Compute Engine virtual machines whose number and type you can control. If you need more or less processing power while your cluster’s running, you can scale it up or down. You can use the default configuration for the Hadoop software in your cluster, or you can customize it. And you can monitor your cluster using Cloud Monitoring.

Why use Dataproc?

- Easily migrate on-premises Hadoop jobs to the cloud.
- Quickly analyze data (like log data) stored in Cloud Storage; create a cluster in 90 seconds or less on average, and then delete it immediately.
- Use Spark/Spark SQL to quickly perform data mining and analysis.
- Use Spark Machine Learning Libraries (MLlib) to run classification algorithms.

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Running on-premises Hadoop jobs requires a hardware investment. On the other hand, running these jobs in Dataproc allows you to pay only for hardware resources during the life of the ephemeral customer you create. You can further save money using preemptible instances for batch processing.

You can also save money by telling Dataproc to use preemptible Compute Engine instances for your batch processing. You have to make sure that your jobs can be restarted cleanly if they're terminated and you get a significant break in the cost of the instances. At the time this video was made, preemptible instances were around 80% cheaper. Be aware that the cost of the Compute Engine instances isn't the only component of the cost of a Dataproc cluster, but it's a significant one.

Once your data is in a cluster, you can use Spark and Spark SQL to do data mining, and you can use MLlib, which is Apache Spark's Machine Learning Libraries, to discover patterns through machine learning.

Dataflow offers managed data pipelines

- Processes data using Compute Engine instances.
  - Clusters are sized for you.
  - Automated scaling, no instance provisioning required.
- Write code once and get batch and streaming.
  - Transform-based programming model.

Google Cloud

Dataproc is great when you have a dataset of known size, or when you want to manage your cluster size yourself. But what if your data shows up in realtime? Or it's of unpredictable size or rate? That's where Dataflow is a particularly good choice. It's both a unified programming model and a managed service, and it lets you develop and execute a big range of data processing patterns: extract-transform-and-load, batch computation, and continuous computation. You use Dataflow to build data pipelines, and the same pipelines work for both batch and streaming data.

Dataflow is a unified programming model and a managed service for developing and executing a wide range of data processing patterns including ETL, batch computation, and continuous computation. Dataflow frees you from operational tasks like resource management and performance optimization.

Dataflow features:

Resource Management: Dataflow fully automates management of required processing resources. No more spinning up instances by hand.

On Demand: All resources are provided on demand, enabling you to scale to meet your business needs. No need to buy reserved compute instances.

Intelligent Work Scheduling: Automated and optimized work partitioning which can dynamically rebalance lagging work. No more chasing down "hot keys" or pre-processing your input data.

Auto Scaling: Horizontal auto scaling of worker resources to meet optimum throughput requirements results in better overall price-to-performance.

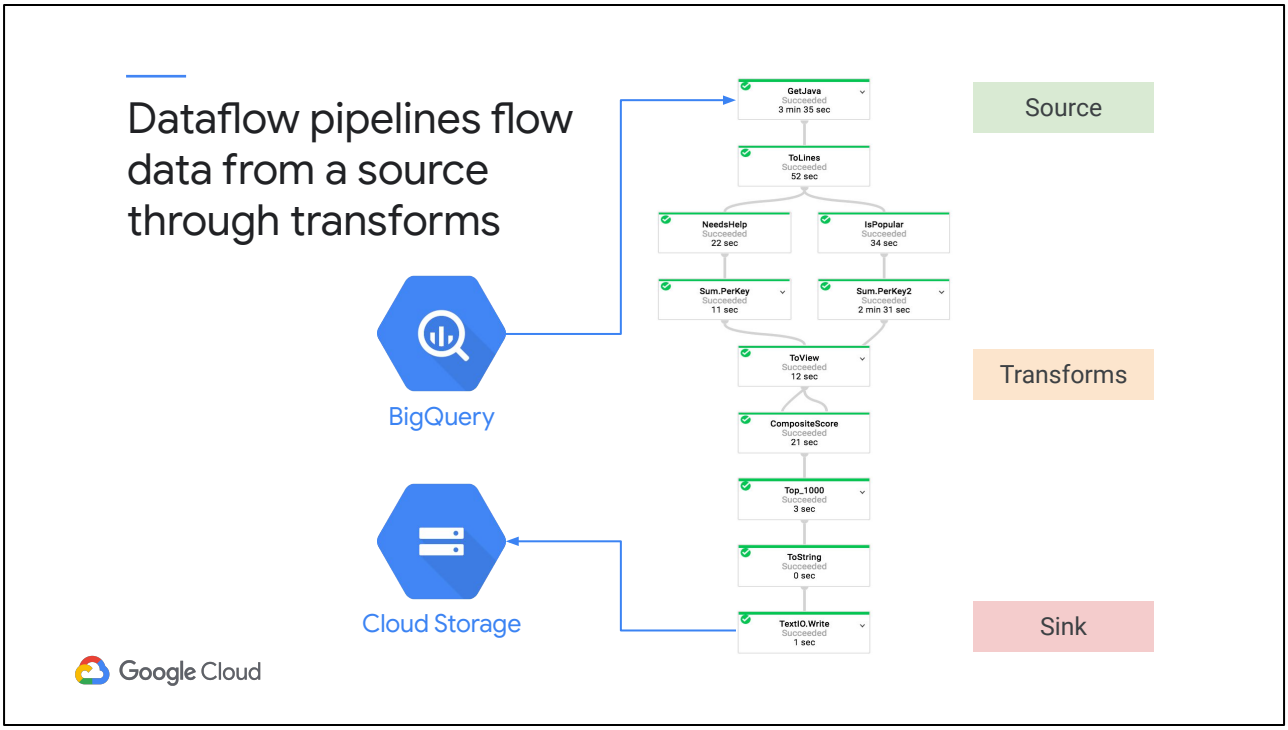
Unified Programming Model: The Dataflow API enables you to express MapReduce like operations, powerful data windowing, and fine grained correctness control regardless of data source.

Open Source: Developers wishing to extend the Dataflow programming model can fork and or submit pull requests on the Java-based Dataflow SDK. Dataflow pipelines can also run on alternate runtimes like Spark and Flink.

Monitoring: Integrated into the Cloud Console, Dataflow provides statistics such as pipeline throughput and lag, as well as consolidated worker log inspection—all in near-real time.

Integrated: Integrates with Cloud Storage, Pub/Sub, Datastore, Cloud Bigtable, and BigQuery for seamless data processing. And can be extended to interact with others sources and sinks like Apache Kafka and HDFS.

Reliable & Consistent Processing: Dataflow provides built-in support for fault-tolerant execution that is consistent and correct regardless of data size, cluster size, processing pattern or pipeline complexity.



This example Dataflow pipeline reads data from a BigQuery table (the “source”), processes it in various ways (the “transforms”), and writes its output to Cloud Storage (the “sink”). Some of those transforms you see here are map operations, and some are reduce operations. You can build really expressive pipelines.

Each step in the pipeline is elastically scaled. There is no need to launch and manage a cluster. Instead, the service provides all resources on demand. It has automated and optimized work partitioning built in, which can dynamically rebalance lagging work. That reduces the need to worry about “hot keys” -- that is, situations where disproportionately large chunks of your input get mapped to the same custer.

Why use Dataflow?

- *ETL* (extract/transform/load) pipelines to move, filter, enrich, shape data.
- *Data analysis*: batch computation or continuous computation using streaming.
- *Orchestration*: create pipelines that coordinate services, including external services.
- Integrates with Google Cloud services like Cloud Storage, Pub/Sub, BigQuery, and Cloud Bigtable.
  - Open source Java and Python SDKs.

Google Cloud

People use Dataflow in a variety of use cases. For one, it serves well as a general-purpose ETL tool.

And its use case as a data analysis engine comes in handy in things like these: fraud detection in financial services; IoT analytics in manufacturing, healthcare, and logistics; and clickstream, Point-of-Sale, and segmentation analysis in retail.

And, because those pipelines we saw can orchestrate multiple services, even external services, it can be used in real time applications such as personalizing gaming user experiences.

BigQuery is a fully managed data warehouse

- Provides near real-time interactive analysis of massive datasets (hundreds of TBs).
- Query using SQL syntax (SQL 2011).
- No cluster maintenance is required.

Google Cloud

If, instead of a dynamic pipeline, you want to do ad-hoc SQL queries on a massive dataset, that is what BigQuery is for. BigQuery is Google's fully managed, petabyte scale, low cost analytics data warehouse.

BigQuery is Google's fully managed, petabyte scale, low cost analytics data warehouse. BigQuery is NoOps: there is no infrastructure to manage and you don't need a database administrator, so you can focus on analyzing data to find meaningful insights, use familiar SQL, and take advantage of our pay-as-you-go model. BigQuery is a powerful big data analytics platform used by all types of organizations, from startups to Fortune 500 companies.

BigQuery's features:

Flexible Data Ingestion: Load your data from Cloud Storage or Datastore, or stream it into BigQuery at 100,000 rows per second to enable real-time analysis of your data.

Global Availability: You have the option to store your BigQuery data in European locations while continuing to benefit from a fully managed service, now with the option of geographic data control, without low-level cluster maintenance.

Security and Permissions: You have full control over who has access to the data stored in BigQuery. If you share datasets, doing so will not impact your cost or performance; those you share with pay for their own queries.

Cost Controls: BigQuery provides cost control mechanisms that enable you to cap your daily costs at an amount that you choose. For more information, see Cost Controls.

Highly Available: Transparent data replication in multiple geographies means that your data is available and durable even in the case of extreme failure modes.

Super Fast Performance: Run super-fast SQL queries against multiple terabytes of data in seconds, using the processing power of Google's infrastructure.

Fully Integrated In addition to SQL queries, you can easily read and write data in BigQuery via Dataflow, Spark, and Hadoop.

Connect with Google Products: You can automatically export your data from Google Analytics Premium into BigQuery and analyze datasets stored in Google Cloud Storage, Google Drive, and Google Sheets.

BigQuery can make Create, Replace, Update, and Delete changes to databases, subject to some limitations and with certain known issues.

BigQuery runs on Google's high-performance infrastructure

- Compute and storage are separated with a terabit network in between.
- You only pay for storage and processing used.
- Automatic discount for long-term data storage.

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It's easy to get data into BigQuery. You can load from Cloud Storage or Datastore, or stream it into BigQuery at up to 100,000 rows per second.

BigQuery is used by all types of organizations, from startups to Fortune 500 companies. Smaller organizations like BigQuery's free monthly quotas. Bigger organizations like its seamless scale and its available 99.9% service level agreement.

Long term storage pricing is an automatic discount for data residing in BigQuery for extended periods of time. When the age of your data reaches 90 days in BigQuery, Google will automatically drop the price of storage from $0.02 per GB per month down to $0.01 per GB per month.

For more information on the architecture of BigQuery, see:
https://cloud.google.com/blog/big-data/2016/01/bigquery-under-the-hood

Pub/Sub is scalable, reliable messaging

- Supports many-to-many asynchronous messaging.
  - Application components make push/pull subscriptions to topics.
- Includes support for offline consumers.
- Based on proven Google technologies.
- Integrates with Dataflow for data processing pipelines.

Google Cloud

Pub/Sub is a fully managed real-time messaging service that allows you to send and receive messages between independent applications. You can leverage Pub/Sub's flexibility to decouple systems and components hosted on Google Cloud or elsewhere on the internet. By building on the same technology Google uses, Pub/Sub is designed to provide "at least once" delivery at low latency with on-demand scalability to 1 million messages per second (and beyond).

Pub/Sub features:

Highly Scalable: Any customer can send up to 10,000 messages per second, by default—and millions per second and beyond, upon request.

Push and Pull Delivery: Subscribers have flexible delivery options, whether they are accessible from the internet or behind a firewall.

Encryption: Encryption of all message data on the wire and at rest provides data security and protection.

Replicated Storage: Designed to provide "at least once" message delivery by storing every message on multiple servers in multiple zones.

Message Queue: Build a highly scalable queue of messages using a single topic and subscription to support a one-to-one communication pattern.

End-to-End Acknowledgement: Building reliable applications is easier with explicit application-level acknowledgements.

Fan-out: Publish messages to a topic once, and multiple subscribers receive copies to support one-to-many or many-to-many communication patterns.

REST API: Simple, stateless interface using JSON messages with API libraries in many programming languages.

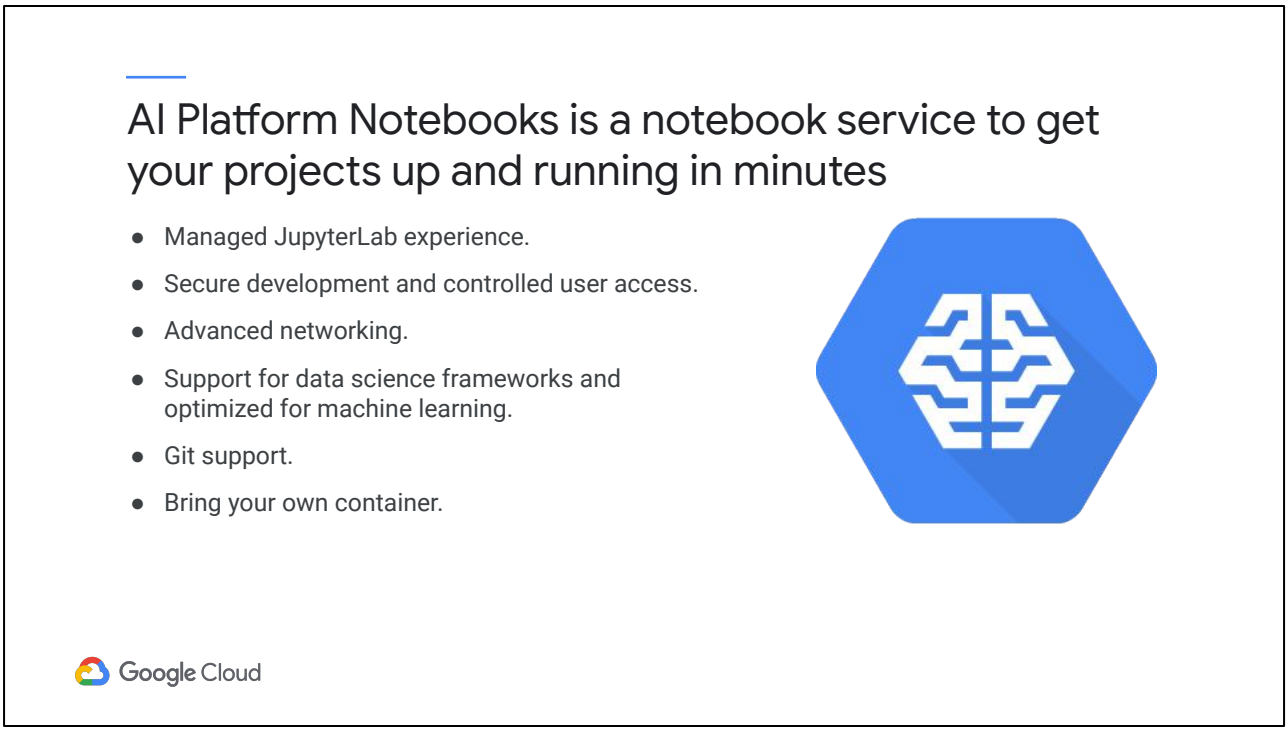
Why use Pub/Sub?

- Building block for data ingestion in Dataflow, Internet of Things (IoT), Marketing Analytics.
- Foundation for Dataflow streaming.
- Push notifications for cloud-based applications.
- Connect applications across Google Cloud (push/pull between Compute Engine and App Engine).

Google Cloud

Pub/Sub builds on the same technology Google uses internally. It's an important building block for applications where data arrives at high and unpredictable rates, like Internet of Things systems. If you're analyzing streaming data, Dataflow is a natural pairing with Pub/Sub.

Pub/Sub also works well with applications built on Google Cloud's compute platforms. You can configure your subscribers to receive messages on a "push" or a "pull" basis. In other words, subscribers can get notified when new messages arrive for them, or they can check for new messages at intervals.



AI Platform Notebooks is a managed service that offers an integrated and secure JupyterLab environment for data scientists and machine learning developers to experiment, develop, and deploy models into production. Users can create instances running JupyterLab that come pre-installed with the latest data science and machine learning frameworks in a single click.

AI Platform Notebooks features:

Managed JupyterLab experience:
AI Platform Notebooks is built on the industry standard JupyterLab. So you can use it with the RPython and R data science community and customize your environment by installing JupyterLab plugins.

Secure development:
AI Platform Notebooks supports popular enterprise security architectures through VPC-SC, shared VPC, and private IP controls. You can also encrypt your data on disk with CMEK.

Controlled user access:
You can choose between two predefined user access modes: restrict AI Platform Notebooks to a single-user or use a service account. You can also customize access based on your enterprise security architecture based on Cloud Identity and Access Management.

Advanced networking:
You can select any virtual private cloud for their AI Platform Notebook instances, provided that they have access either through Google Private Access or the internet to Cloud Storage. You can also turn off public IP address and access your instance via proxy.

Support for data science frameworks:
Google provides a pre-configured environment that supports the most popular data science libraries, including R, pandas, NumPy, SciPy, scikit-learn, and Matplotlib, and ML frameworks like TensorFlow, Keras, fast.ai, RAPIDS, XGBoost, and PyTorch.

Optimized for machine learning:
AI Platform Notebooks' optimized versions of TensorFlow and PyTorch enable you to get the most out of Google Cloud hardware and seamlessly add and remove GPUs from your instance.

Git support:
It’s easy to pull and push notebooks from your Git repository, making it also easy to share your notebooks with colleagues.

Bring your own container:
You can run a AI Platform Notebook instance on a container of your choice. This provides you the flexibility to install specific libraries mandated by your organization or preconfigure the environment running JupyterLab to your preference.

Why use AI Platform Notebooks?

- Get up and running fast. Deploy new JupyterLab instances with one click.
  - Instances are preconfigured with optimized versions of popular data science and ML libraries.
- Scale on demand.
- Seamless experience.

Google Cloud

You can deploy new JupyterLab instances with one click and start analyzing your data immediately. Each instance comes pre-configured with optimized versions of the most popular data science and machine learning libraries including TensorFlow, Keras, PyTorch, fast.ai, RAPIDS, NumPy, scikit-learn, pandas, and Matplotlib.

You can start small and scale up by adding CPUs, RAM, and GPUs. When your data gets too big for one machine, you can seamlessly switch to distributed services like BigQuery, Dataproc, Dataflow, and AI Platform Training and Prediction. You pay for the instances only while they are running.

You can go from data to a deployed machine learning model without leaving AI Platform Notebooks. You can pull data from BigQuery, use Dataproc to transform it, and leverage AI Platform services or Kubeflow for distributed training and online prediction.

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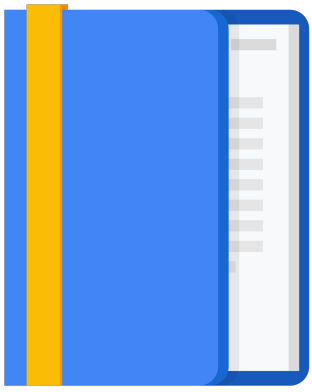

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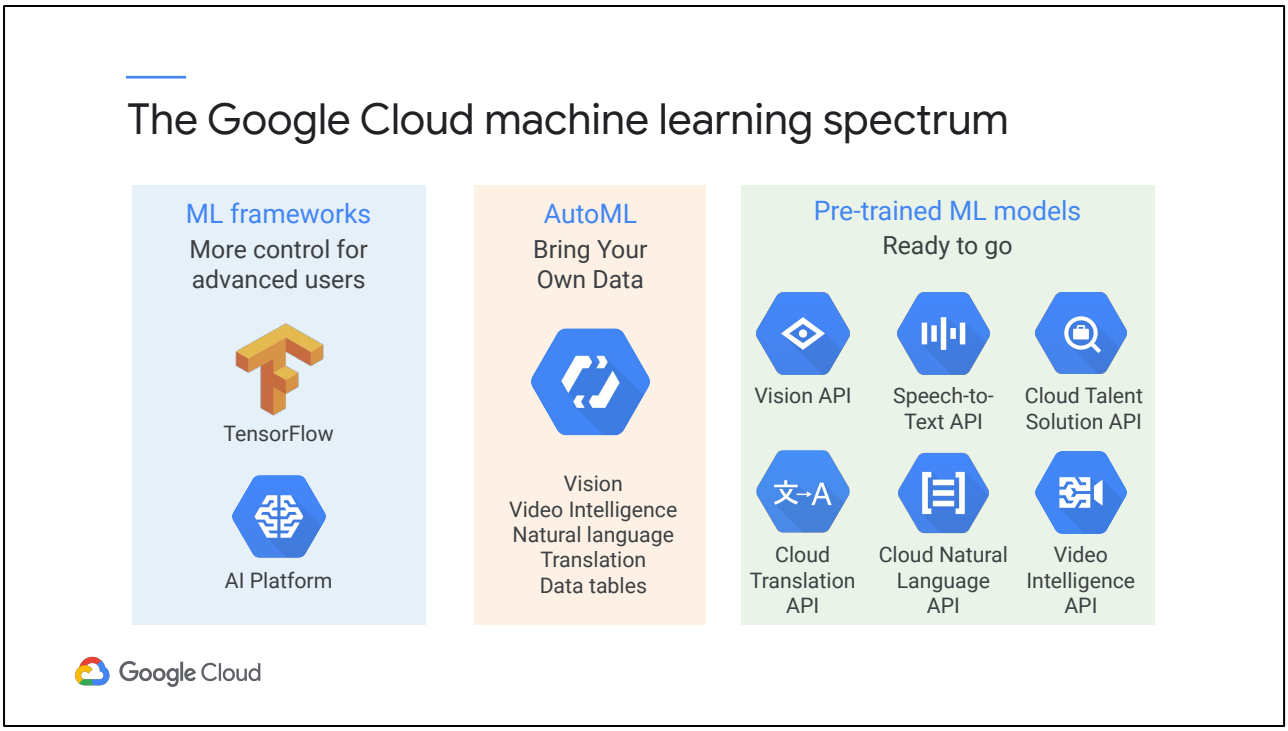


Different options exist when it comes to leveraging machine learning. Advanced users, who want more control over the building and training of ML models, will use tools that offer the levels of flexibility they are looking for. This would involve developing custom models through an ML library like TensorFlow, that's supported on Cloud ML Engine, which is now a part of AI Platform. This option works for data scientists with the skills and the need to create a TensorFlow model.

But increasingly, you don't have to do that. Google makes the power of ML available to you even if you have a limited knowledge of ML. You can use AutoML to build on Google's ML capabilities to create your own custom ML models that are tailored to specific business needs, and then integrate those models into applications and web sites.

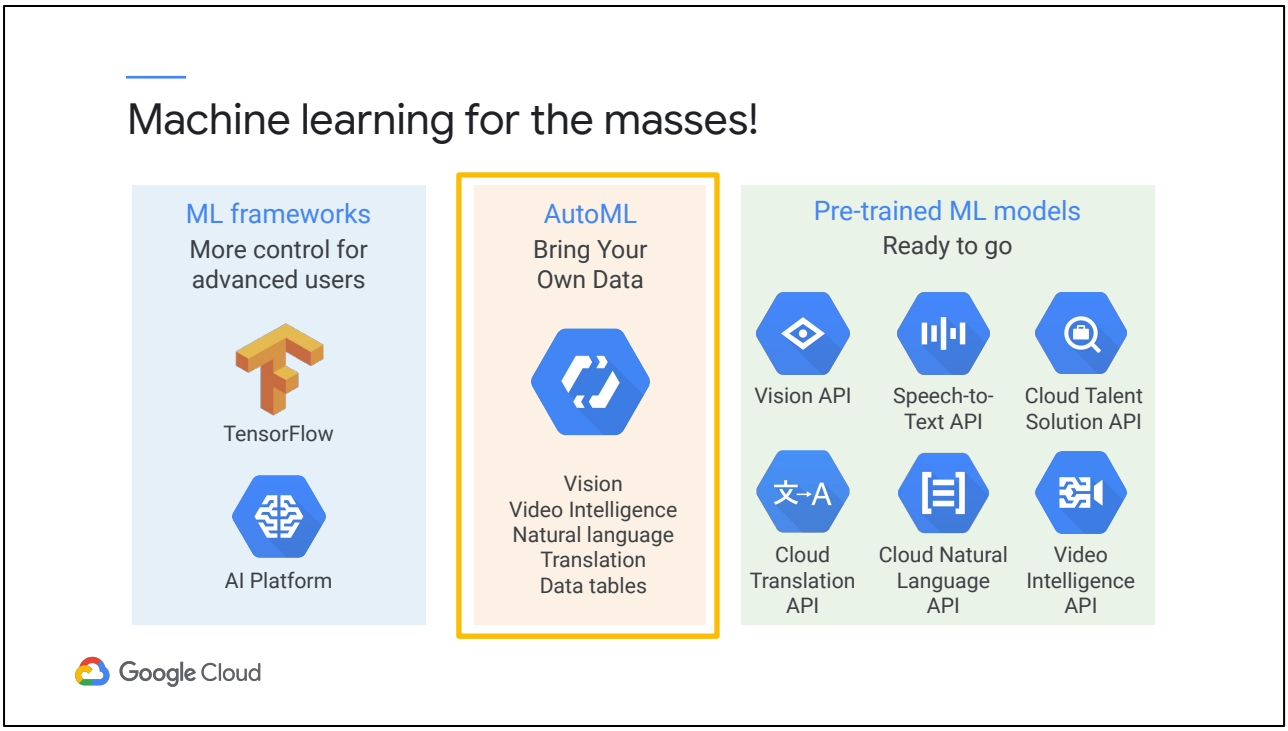
Alternatively, Google has a range of pre-trained ML models that are ready for immediate use within applications in ways that the respective APIs are designed to support. Such pretrained models are excellent ways to replace user input with ML.

Create custom ML models with TensorFlow

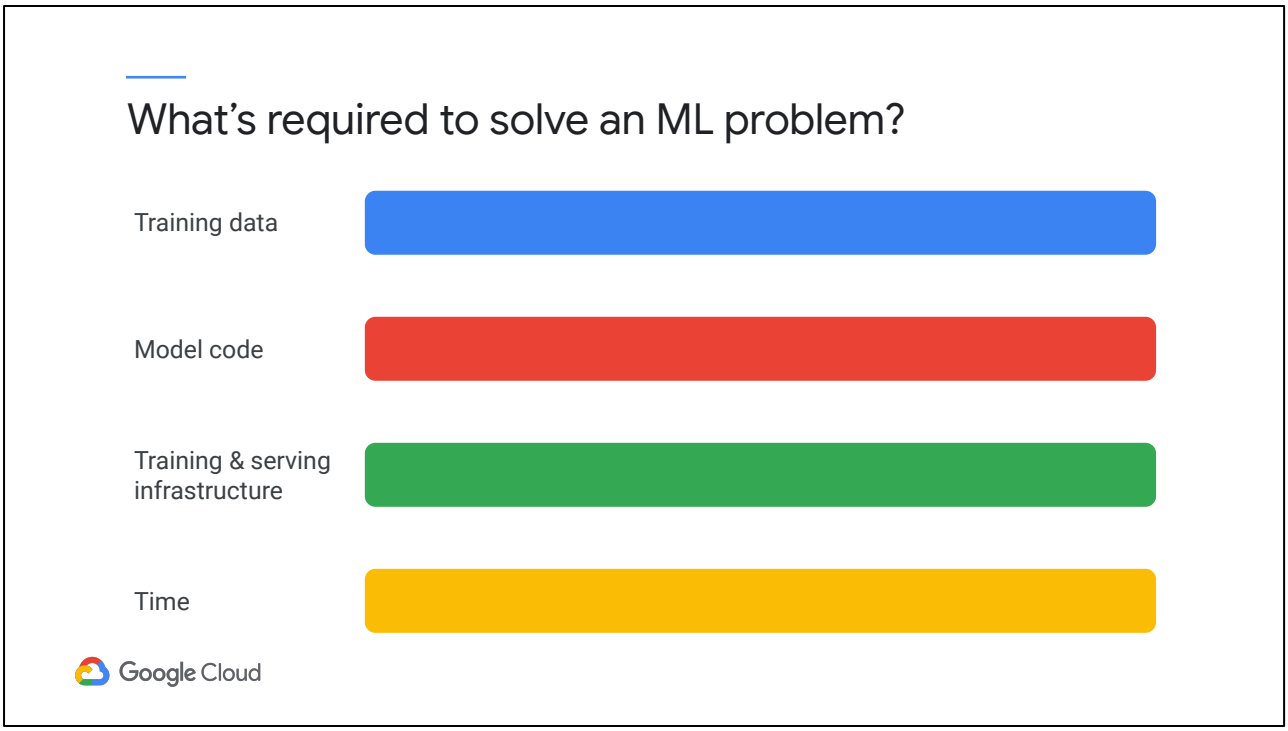
TensorFlow

Google Cloud

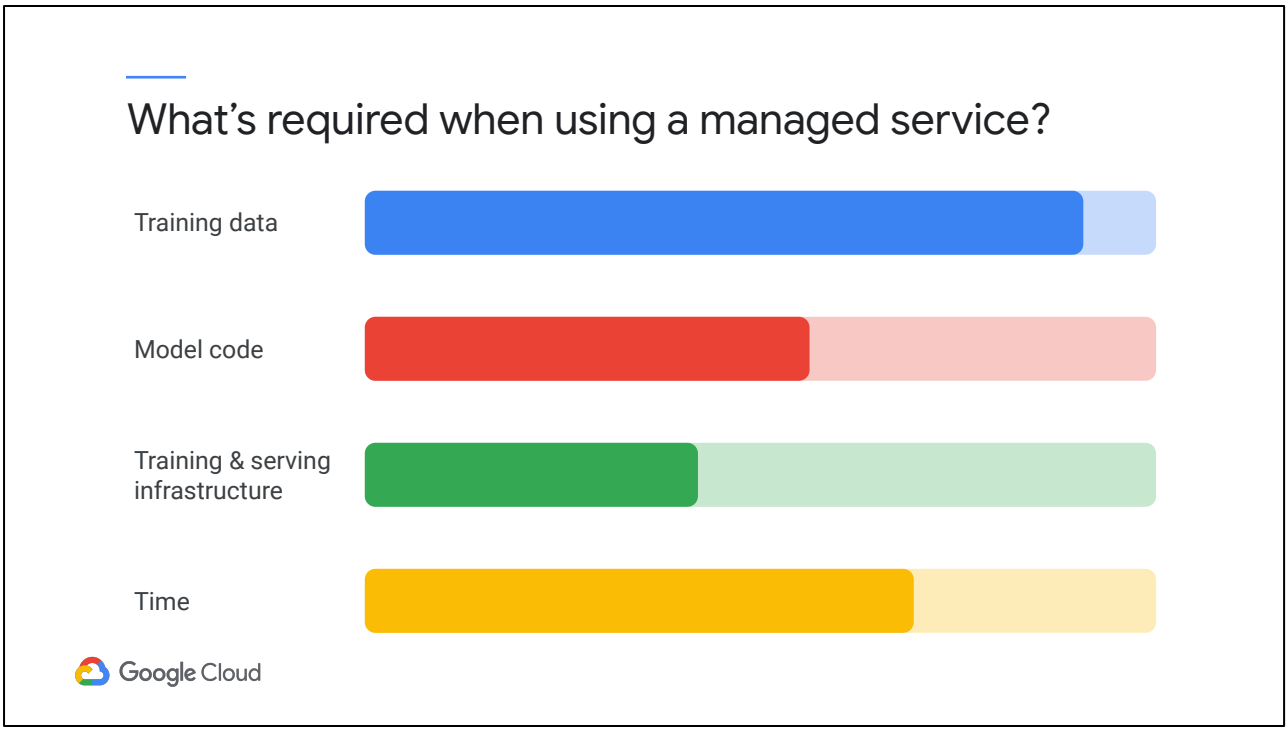
As a starting point, let's talk a little bit about TensorFlow. TensorFlow is an open-source high-performance library for numerical computation. Not just about machine learning. Any numeric computation. In fact, people have used TensorFlow for all kinds of GPU computing; for example, you can use TensorFlow to solve partial differential equations -- these are useful in domains like fluid dynamics. TensorFlow as a numeric programming library is appealing because you can write your computation code in a high-level language -- Python -- and have it be executed in a fast way.



AutoML is a suite of ML products that enables users with limited ML expertise to train high-quality models specific to their business needs. AutoML leverages more than 10 years of proprietary Google Research technology to help users' ML models achieve faster performance and more accurate predictions.

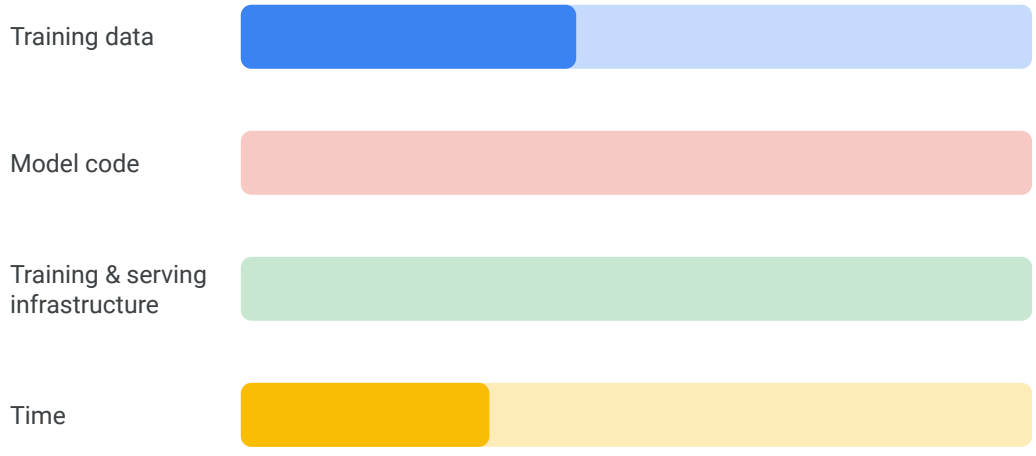


To put AutoML into context, let's look at what it takes to solve an ML problem. To solve an ML problem without the benefit of a managed service, it's up to you to wrangle your data, code your model, and put together the infrastructure. This can be prohibitively complex and time consuming.



Earlier, we discussed how Cloud ML Engine, a managed service that's part of AI Platform, lets developers and data scientists build and run superior learning models in production. As reflected in this graphic, there's a considerable reduction in the required training and serving infrastructure as well as the amount of model code. However, there's still a requirement to provide extensive training data, and the process is still a time-consuming one.

What's required when using AutoML?



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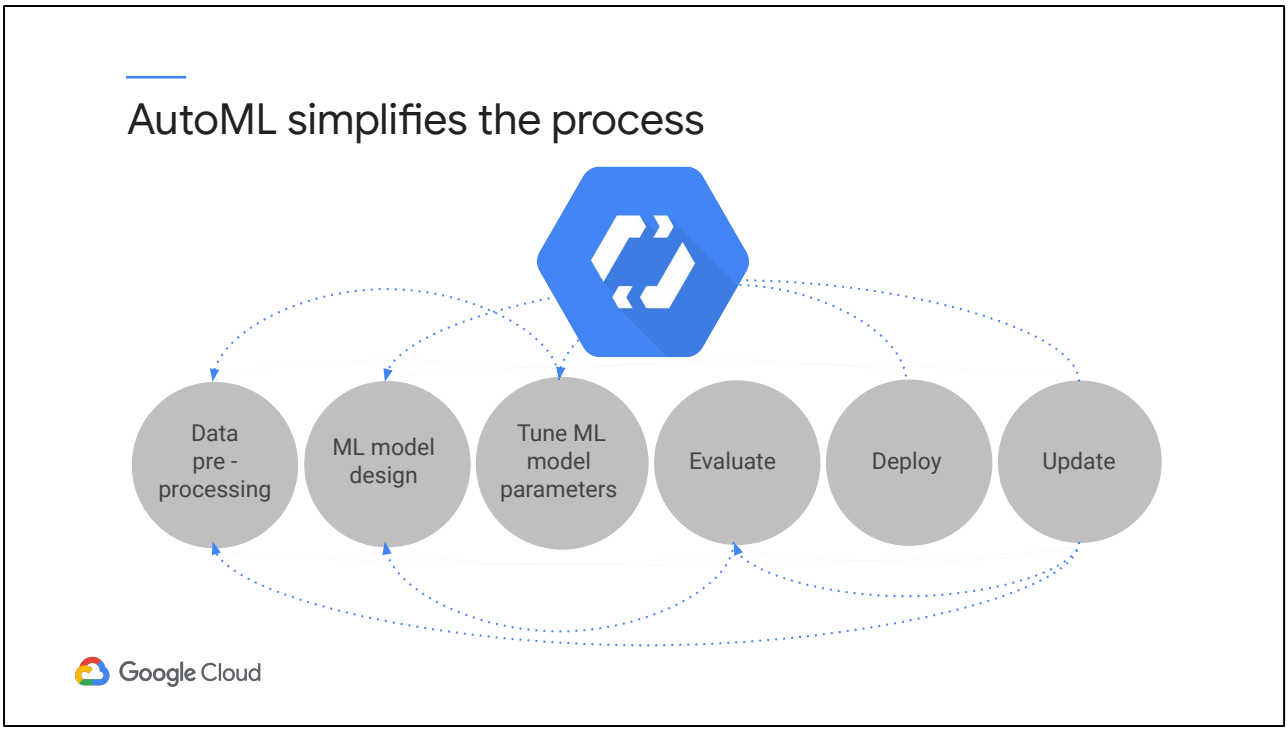
What's immediately notable with AutoML is that there's no requirement on the users' side to develop a model or provide a training and serving infrastructure. In addition, far less training data is required, and results are achieved a lot faster.



The ability of AutoML to efficiently solve an ML problem is largely due to how it simplifies these complex steps that are associated with custom ML model building.

Use AutoML for what you can see

AutoML Vision

Derive insights from images in the cloud or at the edge.

AutoML Video Intelligence

Enable powerful content discovery and engaging video experiences.

Google Cloud

There are two AutoML products that apply to what you can see.

With AutoML Vision, you simply upload images and train custom image models through an easy-to-use graphical interface You can optimize your model for accuracy, latency, and size. AutoML Vision Edge allows you to export your custom trained models to an application in the cloud, or to an array of devices at the edge. You can train models to classify images through labels you choose. Alternatively Google's data labeling service allows you to use their team to help annotate your images, videos, and text. Later, we'll complete a lab where we'll use AutoML Vision to train a custom model to recognize different types of clouds.

AutoML Video Intelligence makes it easy to train custom models to classify and track objects within videos. It's ideal for projects that require custom entity labels to categorize content which aren't covered by the pre-trained Video Intelligence API.

Use AutoML for what you can hear

AutoML Natural Language

Reveal the structure and meaning of text through machine learning.

AutoML Translation

Dynamically translate between languages.

Google Cloud

There are also two AutoML products that apply to what you can hear.

With AutoML Natural Language, you can train custom ML models to classify, extract, and detect sentiment. This allows you to identify entities within documents and label them based on your own domain-specific keywords or phrases. The same applies to being able to understand the overall opinion, feeling, or attitude expressed in a block of text that's tuned to domain-specific sentiment scores.

AutoML Translation allows you to upload translated language pairs and it will train a custom model which translation queries return results specific to your domain, and that you can scale and adapt to meet your needs.

Use AutoML to turn structured data into predictive insights

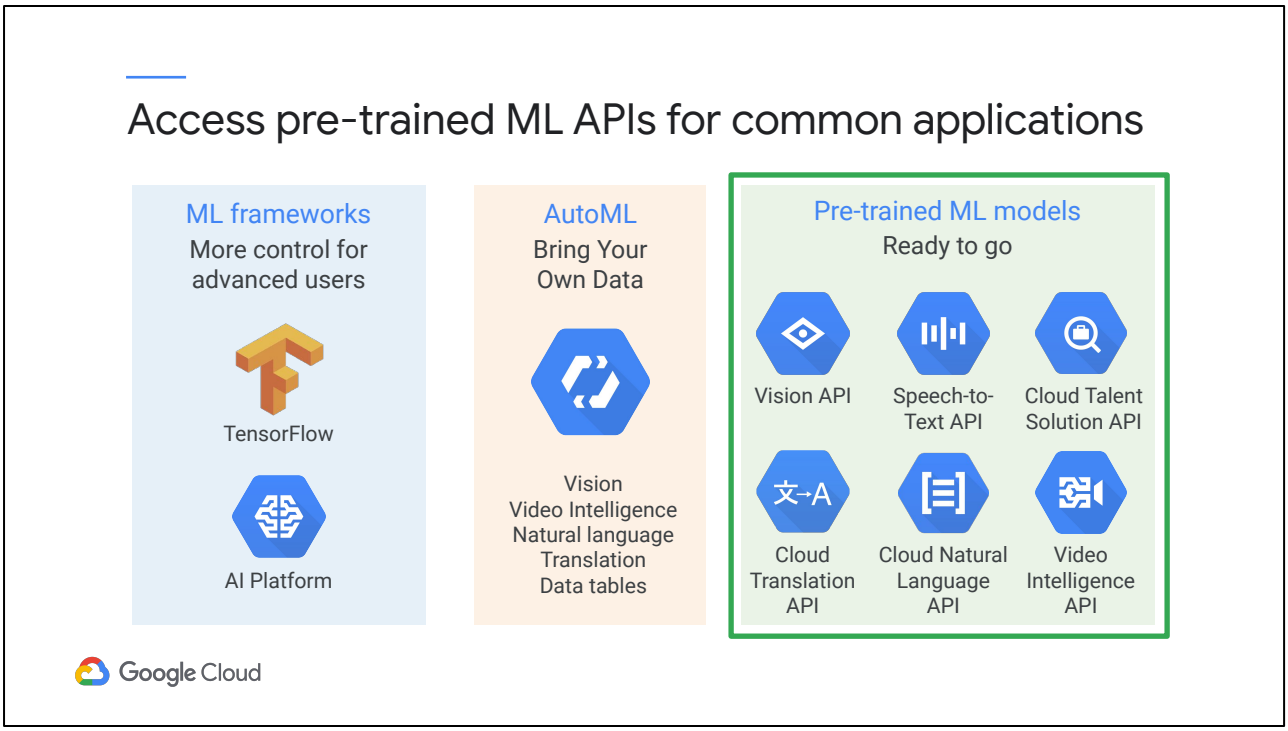
AutoML Tables

Automatically build and deploy state-of-the-art machine learning models on structured data.

Google Cloud

AutoML Tables reduces the time it takes to go from raw data to top-quality, production-ready machine learning models from months to just a few days.

There are many different use cases for AutoML Tables. For example, if you're in retail, you can better predict customer demand so you can preemptively fill gaps and maximize your revenue by optimizing product distribution, promotions, and pricing. In insurance, you could foresee and optimize a policyholder portfolio's risk and return by zeroing in on the potential for large claims and likelihood of fraud. In marketing, you can better understand your customer. For example, What's your average customer's lifetime value? You can make the most of marketing spend by using AutoML Tables to estimate predicted purchasing value, volume, frequency, lead conversion probability, and churn likelihood.



APIs like the Vision API or Natural Language Processing or Translation are already trained for common ML use cases like Image Classification. They save you the time and effort of building, curating, and training a new dataset so you can just jump ahead right to predictions.

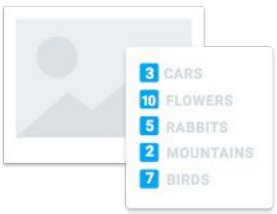
For pre-trained models, Google has already figured out a lot of the hard problems: the Vision API is based on Google's image datasets, the Speech-to-Text API is trained on YouTube captions, and the Cloud Translation API is built on parallel texts for language translations. Remember, how well your model is trained depends on how much data you have. As you would expect, Google has a lot of images and text and ML researchers to train it's pre-built models, so you can use those instead of reinventing the wheel.

For example, if you're looking to have captions included in a recent webinar that you've hosted, consider using the Cloud Translation or Speech-to-Text APIs instead of trying to build a language recognition ML model yourself.

Another example, if you have text documents like expense receipts that you need classified by expense type, consider using the Vision API for OCR so you can mine the text from the receipts and drop the data into something like BigQuery.

Let's explore some of these pre-trained machine learning APIs.

Use the Vision API to understand image content



Detect and label

Extract text

Identify entities

Google Cloud

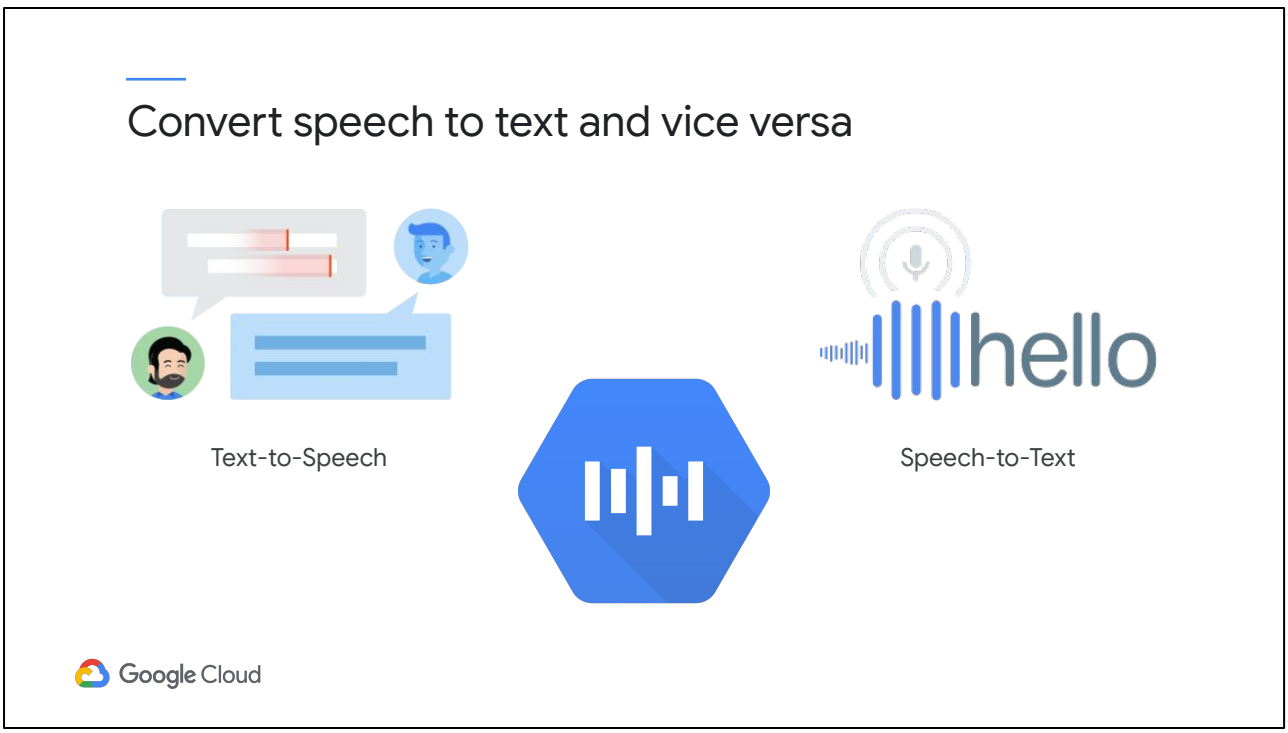
Let's start with the Vision API. There are three major components that all roll up into this REST API, and behind-the-scenes each of these are powered by many ML models and years of research.

The first is detecting what an image is and classifying it. The Vision API picks out the dominant entity, for example a car or a cat, within an image from a broad set of object categories. This allows you to easily detect broad sets of objects in your images. Facial detection can detect when a face appears in photos, along with associated facial features such as eye, nose and mouth placement, and likelihood of over 8 attributes like joy and sorrow. Facial recognition however, isn't supported and Google doesn't store facial detection information on any Google server. You can use the API to easily build metadata on your image catalog, enabling new scenarios like image based searches or recommendations.

Next, are images with text, like scanned documents or signs. The Vision API uses optical character recognition, or OCR, to extract the text of a wide range of languages into a selectable, searchable format.

Lastly is a bit of intuition from the web and uses the power of Google Image Search. Does the image contain entities we know, like the Eiffel tower or a famous person? Landmark detection allows you to identify popular natural and manmade structures, along with the associated latitude and longitude of the landmark, and logo detection allows you to identify product logos within an image.

You can build metadata on your image catalog, extract text, moderate offensive content, or enable new marketing scenarios through image sentiment analysis. You can also analyze images uploaded in the request or integrate with an image storage on Cloud Storage.

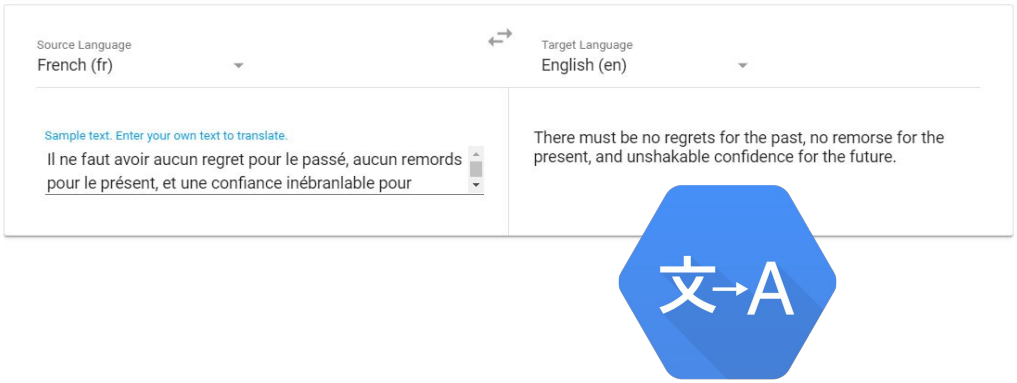


There are two APIs that apply to speech.

The Text-to-Speech API converts text into human-like speech in more than 180 voices across more than 30 languages and variants. It applies research in speech synthesis and Google's powerful neural networks to deliver high-fidelity audio. With this API, you can create lifelike interactions with users that transform customer service, device interaction, and other applications.

The Speech-to-Text API enables you to convert real-time streaming or prerecorded audio to text. The API recognizes 120 languages and variants to support a global user base. You can enable voice command-and-control, transcribe audio from call centers, and so on.

Dynamically translate between languages using the Cloud Translation API



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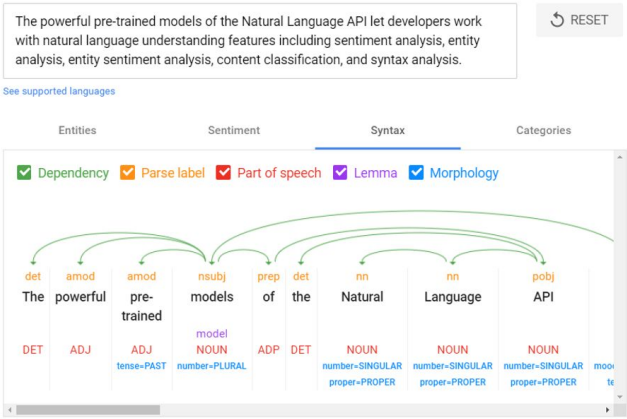
The Cloud Translation API provides a simple programmatic interface for translating an arbitrary string into any supported language. The Cloud Translation API is highly responsive, so websites and applications can integrate with the API for fast, dynamic translation of source text from the source language to a target language, for example from French to English. Language detection is also available in cases where the source language is unknown.

Let's look at a short video that shows how Bloomberg, a global leader in business and financial data, news and insight, applied the Cloud Translation API to reach all of their customers regardless of language.

Derive insights from unstructured text with the Cloud Natural Language API



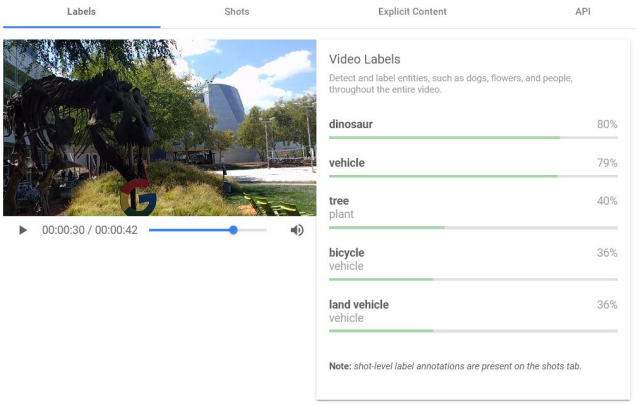
Google Cloud

The Cloud Natural Language API offers a variety of natural language understanding technologies. It can do syntax analysis, breaking down sentences into tokens, identify the nouns, verbs, adjectives, and other parts of speech, and figuring out the relationships among the words.

It can also do entity recognition, in other words, it can parse text and flag mentions of people, organizations, locations, events, products and media.

Sentiment analysis allows you to understand customer opinions to find actionable product and UX insights.

Make your media more discoverable with the Video Intelligence API



Google Cloud

The Video Intelligence API allows users to use Google video analysis technology as part of their applications. The REST API enables users to annotate videos stored in Cloud Storage with video and 1 frame-per-second contextual information. It helps you identify key entities -- that is, nouns -- within your video, and when they occur. You can use it to make video content searchable and discoverable.

The API supports the annotation of common video formats, including .MOV, .MPEG4, .MP4, and .AVI.

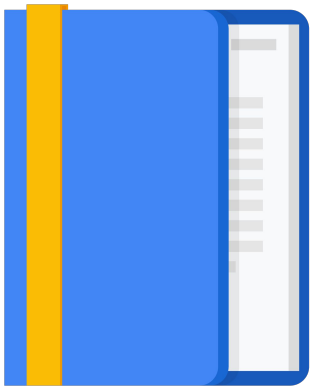
Agenda

Google Cloud Big Data Platform

Machine Learning in the Cloud

Quiz and Lab

Resources



Google Cloud

Quiz 1

When would you use Dataproc?

Quiz 1

When would you use Dataproc?

You can use it to migrate on-premises Hadoop jobs to the cloud. You can also use it for data mining and analysis of cloud-based data.

Quiz 2

Name two use cases for Dataflow.

Quiz 2

Name two use cases for Dataflow.

1. ETL
2. Orchestration

Quiz 3

Which machine learning tool would be the best option for someone that wants a custom model but has limited application development or data science skills?

A. AI Platform

B. AutoML

C. Tensorflow

D. Speech API

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The objectives for this lab are for you to:

- Load data from Cloud Storage into BigQuery.
- Perform a query on the data in BigQuery.

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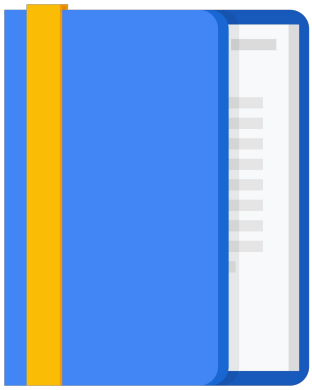

Google Cloud

Resources

Smart Analytics https://cloud.google.com/solutions/smart-analytics

Cloud AI https://cloud.google.com/products/ai/


Google Cloud