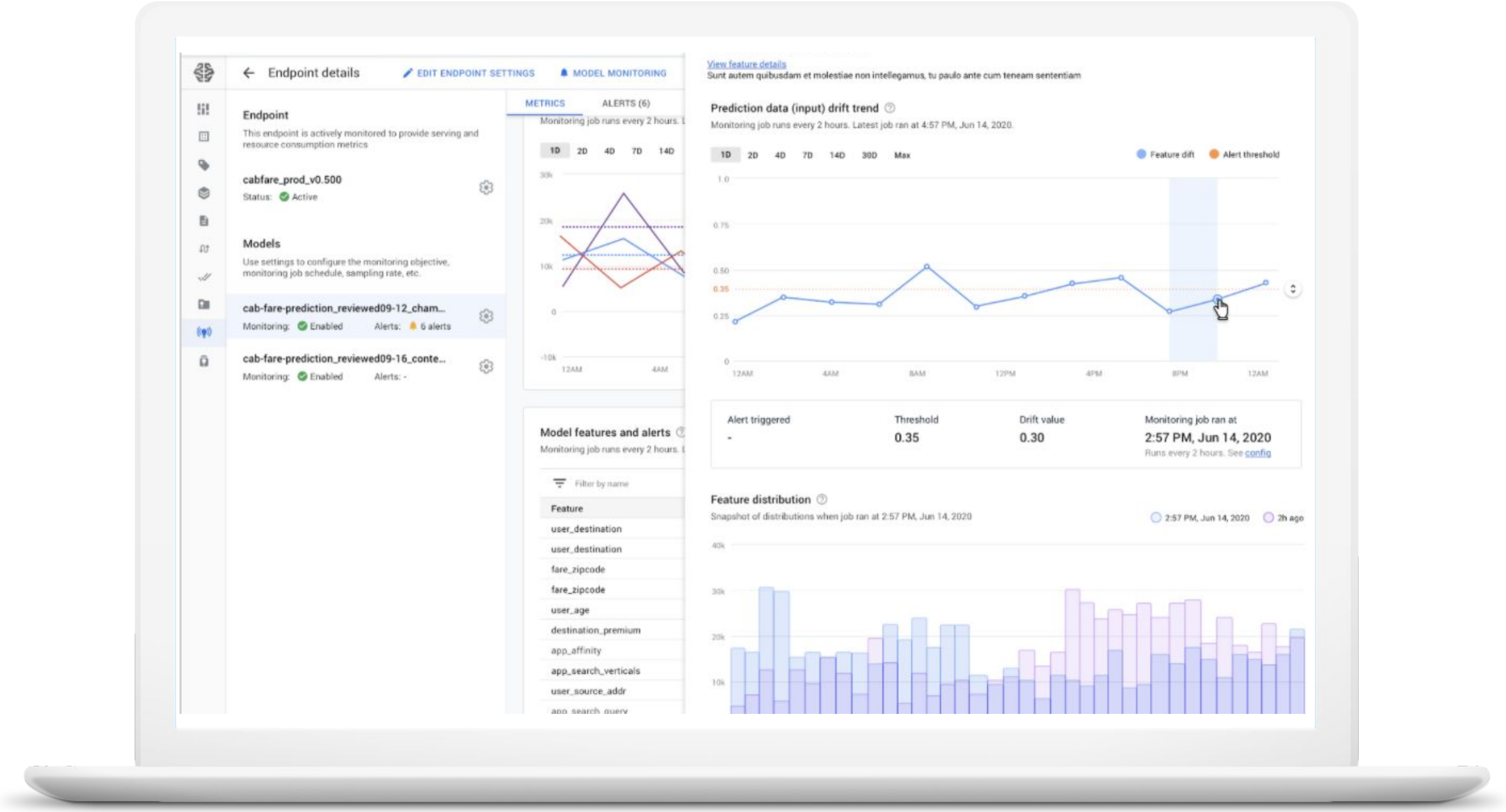
Best practices for machine learning development

Best practices



Endpoint

This endpoint is actively monitored to provide serving and resource consumption metrics

cabfare_prod_v0.500
Status: Active

Models

Use settings to configure the monitoring objective, monitoring job schedule, sampling rate, etc.

cab-fare-prediction_reviewed09-12_cham...
Monitoring: Enabled Alerts: 6 alerts

cab-fare-prediction_reviewed09-16_conte...
Monitoring: Enabled Alerts: -

Monitoring job runs every 2 hours.

Model features and alerts

Monitoring job runs every 2 hours.

Feature
user_destination
user_destination
fare_zipcode
fare_zipcode
user_age
destination_premium
app_affinity
app_search_verticals
user_source_addr
app_search_query

Sunt autem quibusdam et molestiae non intellegamus, tu paulo ante cum teneam sententiam

Prediction data (input) drift trend

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-	0.35	0.30	2:57 PM, Jun 14, 2020 Runs every 2 hours. See config

Feature distribution

Snapshot of distributions when job ran at 2:57 PM, Jun 14, 2020

Data

How it is prepared and stored

Workbench Notebooks

Using Notebooks to evaluate and understand your models

Model

Tips for training, maximizing predictive accuracy, and feature attributions for insights

Tensorboard

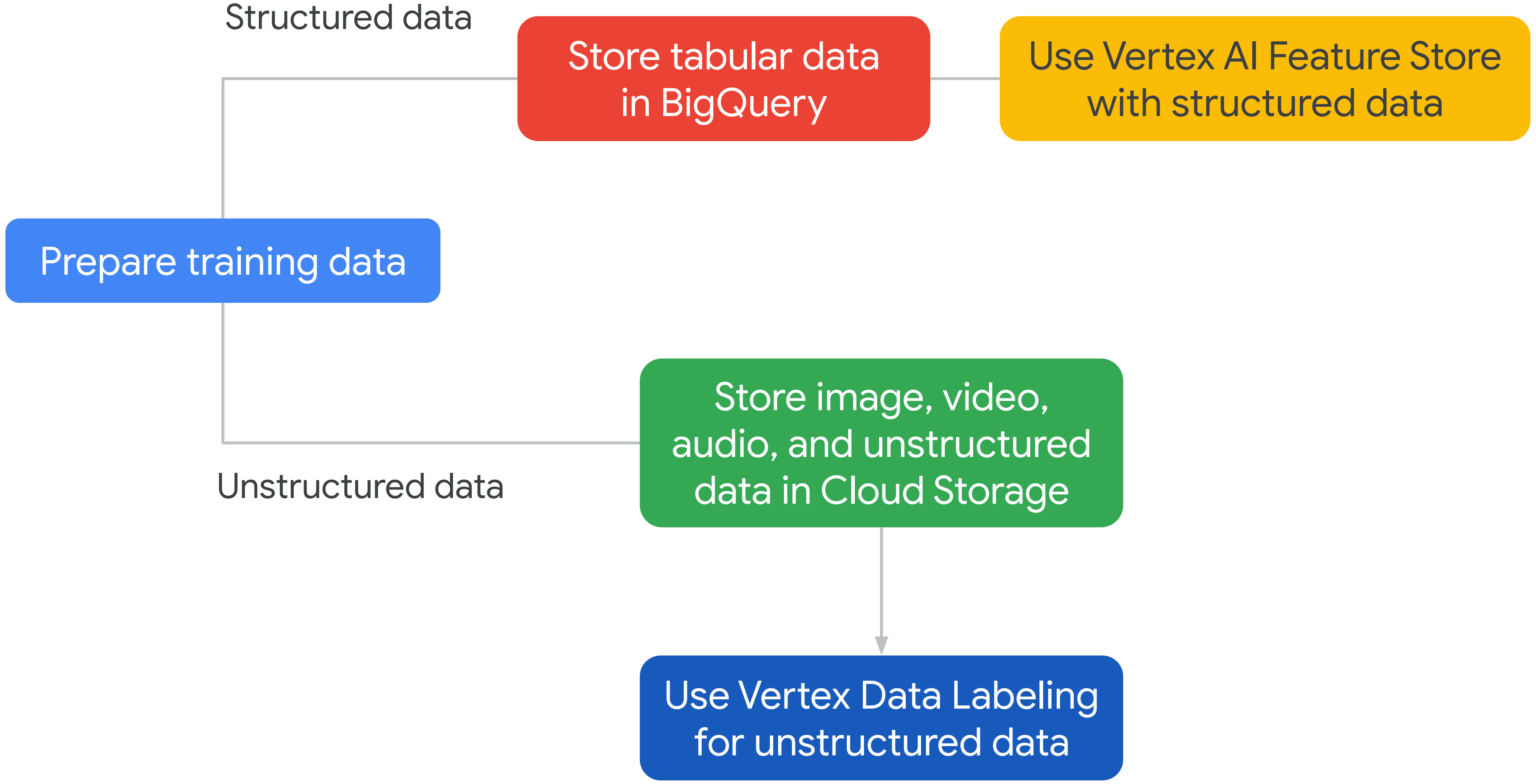
Using Vertex AI TensorBoard to visualize experiments

Best practices for preparing and storing data

Data

How it is prepared and stored

Avoid storing data in block storage


Structured data
Store tabular data in BigQuery
Use Vertex AI Feature Store with structured data
Prepare training data
Unstructured data
Store image, video, audio, and unstructured data in Cloud Storage
Use Vertex Data Labeling for unstructured data

Vertex AI Feature Store

Feature Store

Use Feature Store with structured data

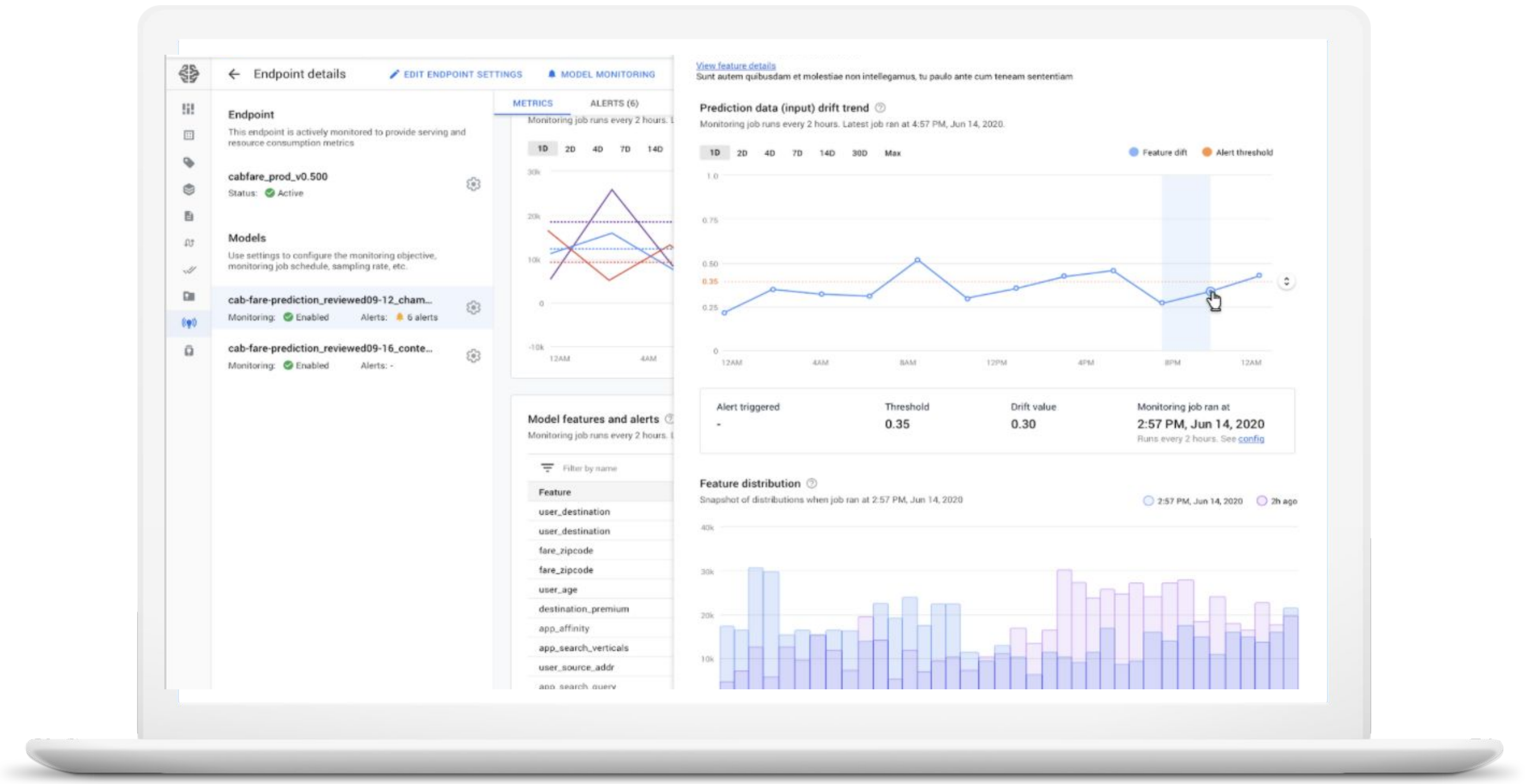
Follow these steps:

1. Search Vertex AI Feature Store
   a. Search to see if a feature already exists.
   b. Fetch those features for your training labels using Vertex AI Feature Store's batch serving capability.
2. Create a new feature
   a. Create a new feature using your Cloud Storage bucket or BigQuery location. OR
   b. Fetch raw data from your data lake and write your scripts to perform feature processing.
   c. Join the feature values and the new feature values. Merging those feature values produces the training data set.

Best practices for training a model

Model

Tips for training, maximizing predictive accuracy, and feature attributions for insights



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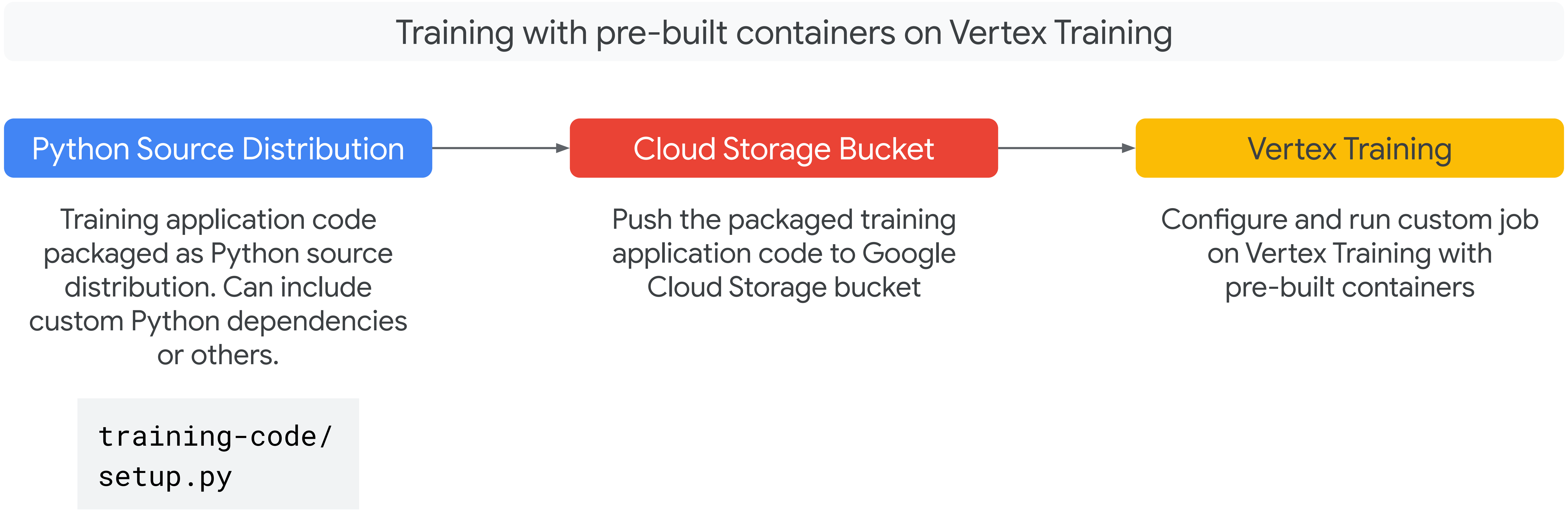
Feature distribution

Snapshot of distributions when job ran at 2:57 PM, Jun 14, 2020

For small datasets, train a model within the Notebooks instance.

For large datasets, distributed training, or scheduled training, use the Vertex training service.

Training with pre-built containers on Vertex AI



Training with pre-built containers on Vertex Training

Python Source Distribution

Training application code packaged as Python source distribution. Can include custom Python dependencies or others.

```
training-code/
setup.py
```

Cloud Storage Bucket

Push the packaged training application code to Google Cloud Storage bucket

Vertex Training

Configure and run custom job on Vertex Training with pre-built containers

Best practices for Explainable AI

Model

Tips for training, maximizing predictive accuracy, and feature attributions for insights

Offers feature attributions to provide insights into why models generate predictions.

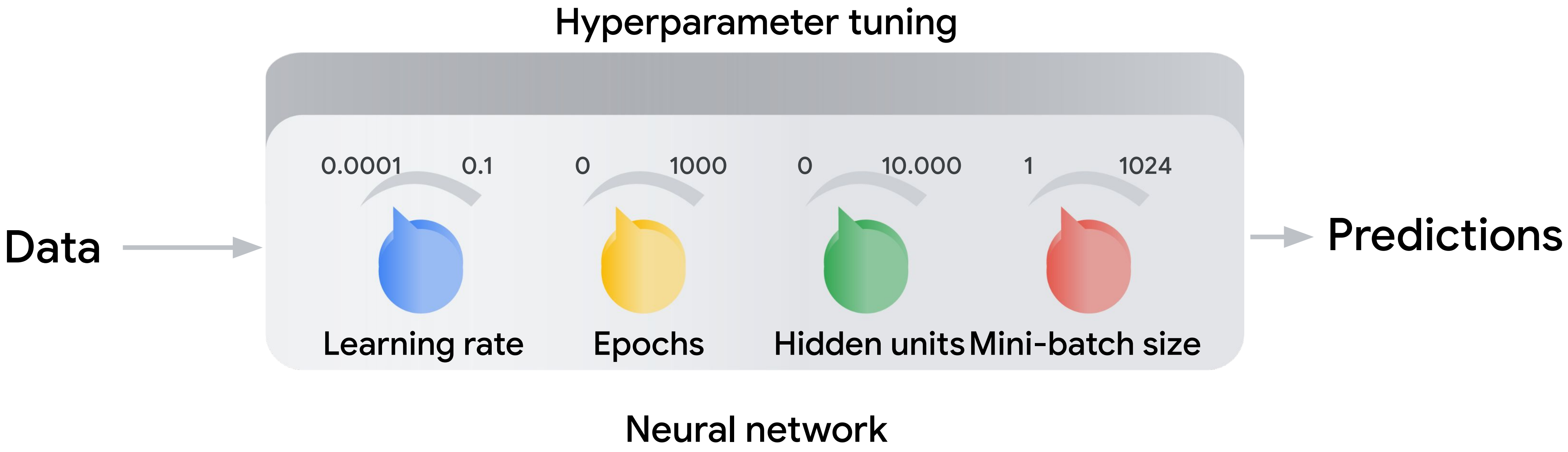
Details the importance of each feature that a model uses as input to make a prediction.

Supports custom-trained models based on tabular and image data.

Hyperparameter tuning with Vertex Training

Model

Maximize your model's predictive accuracy with hyperparameter tuning



The hyperparameters are knobs that act as the network-human interface.

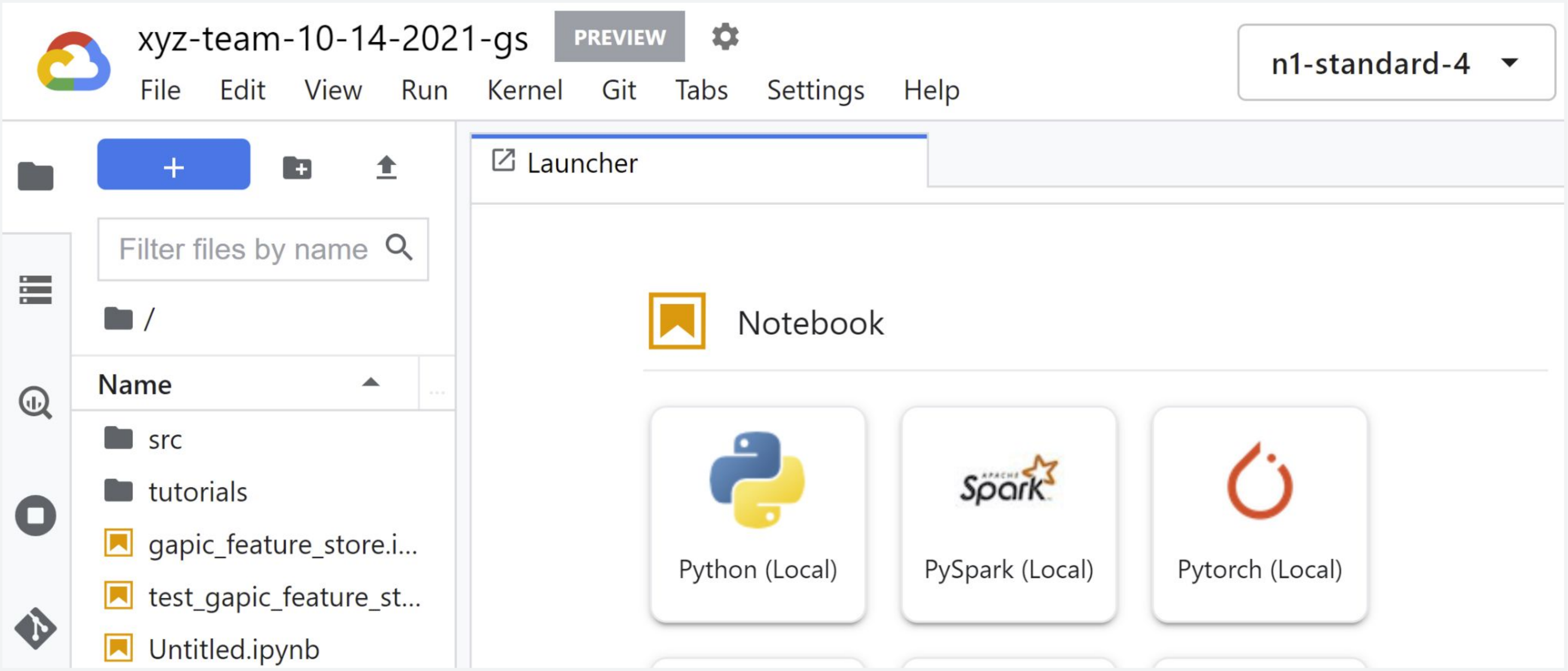
Maximize a model's predictive accuracy. Vertex Training provides an automated model enhancer to test different hyperparameter configurations when training your model.

No need to manually adjust hyperparameters over the course of numerous training runs to arrive at the optimal values.

Best practices for using Workbench Notebooks

Workbench Notebooks

Use Notebooks to evaluate and understand your models.

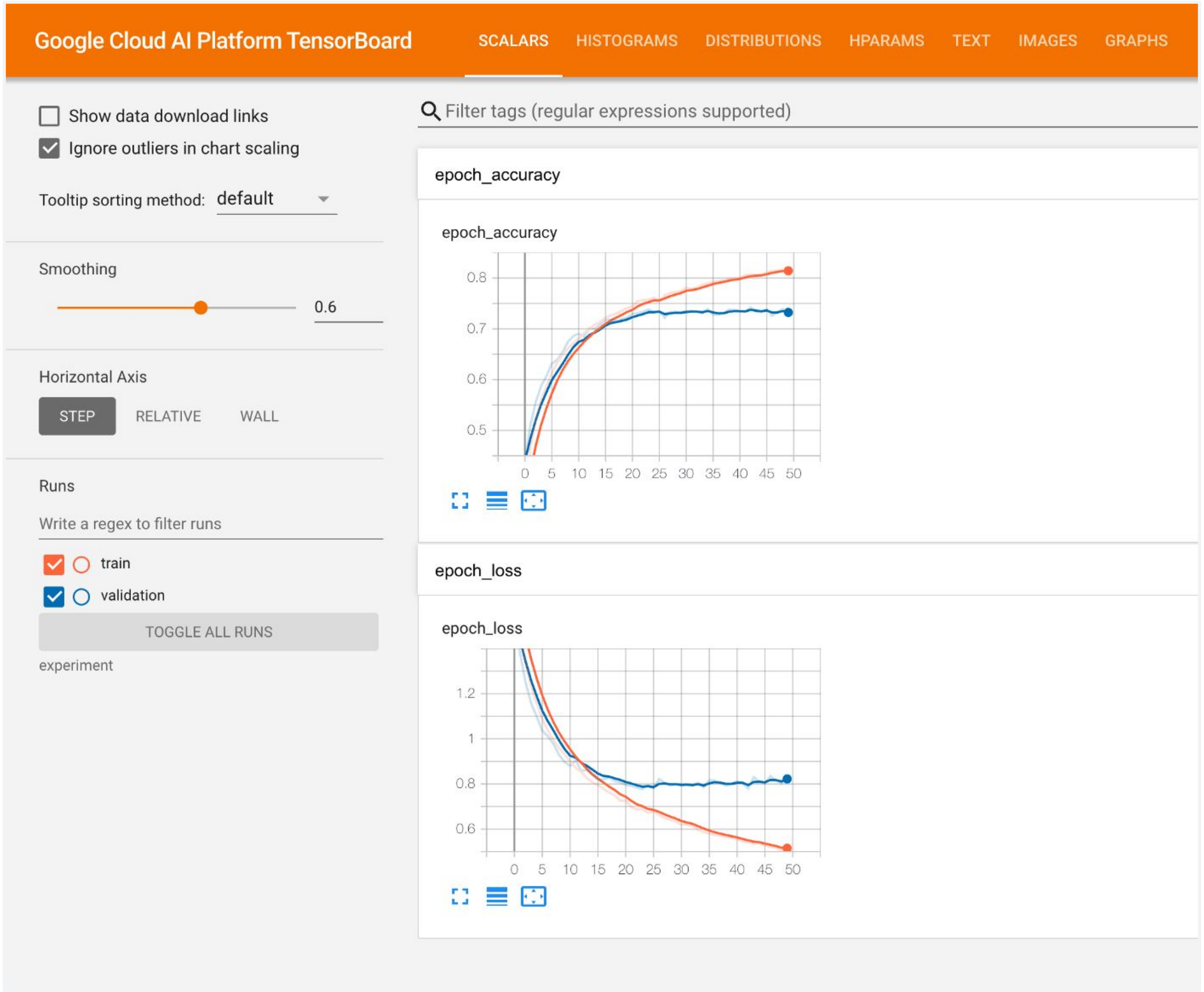


Use Notebooks to evaluate and understand your models. In addition to built-in common libraries like scikit-learn, Notebooks offers What-if Tool (WIT) and Language Interpretability Tool (LIT).

Best practices for using Vertex AI TensorBoard

TensorBoard

Use Vertex AI TensorBoard to visualize experiments.



Google Cloud AI Platform TensorBoard

☐ Show data download links

☑ Ignore outliers in chart scaling

Tooltip sorting method: default

Smoothing 0.6

Horizontal Axis: STEP

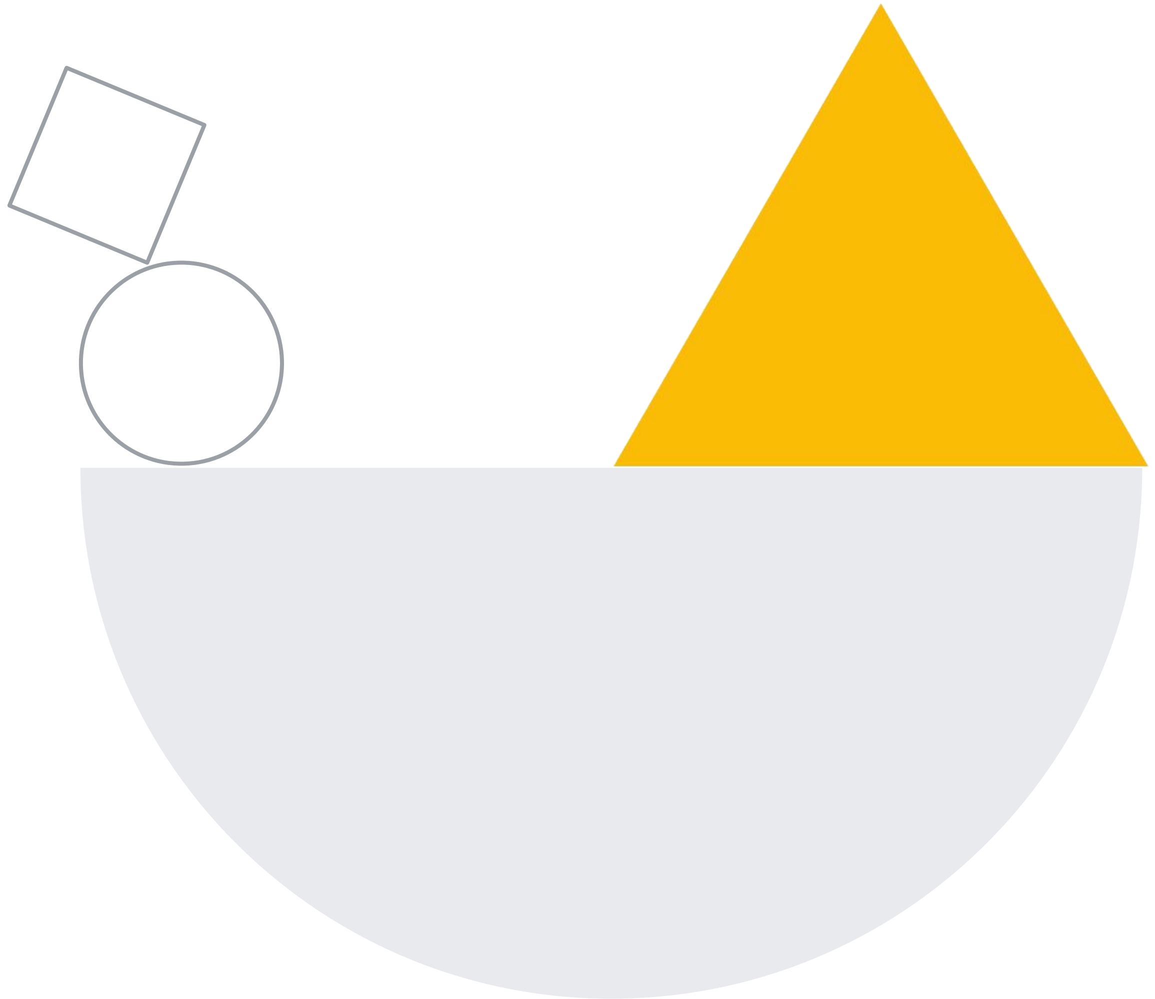
Runs

☑ ○ train

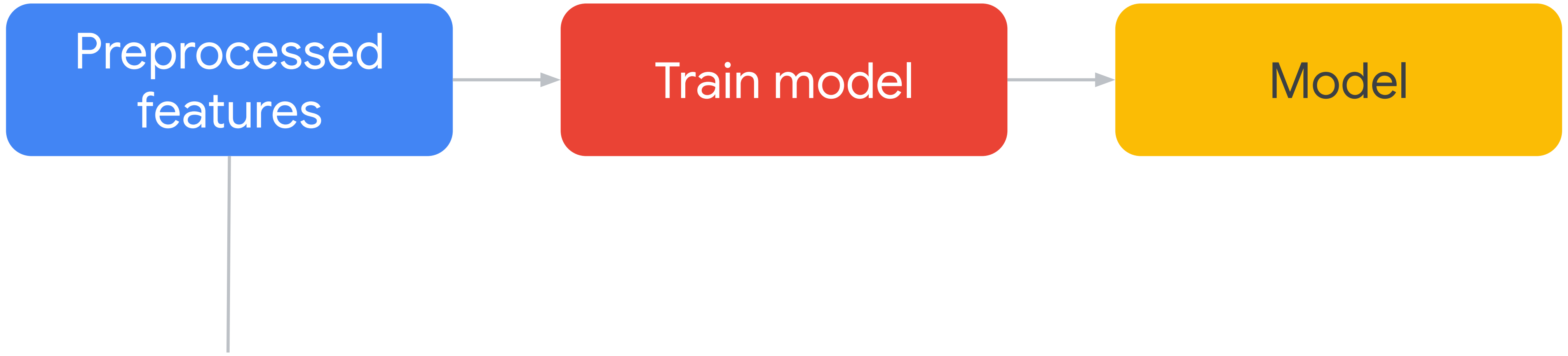
☑ ○ validation

[Vertex AI TensorBoard](#) service lets you track experiment metrics such as loss and accuracy over time, visualize a model graph, project embeddings to a lower dimensional space, and much more.

Data preprocessing best practices



For training and evaluation, we need preprocessed features



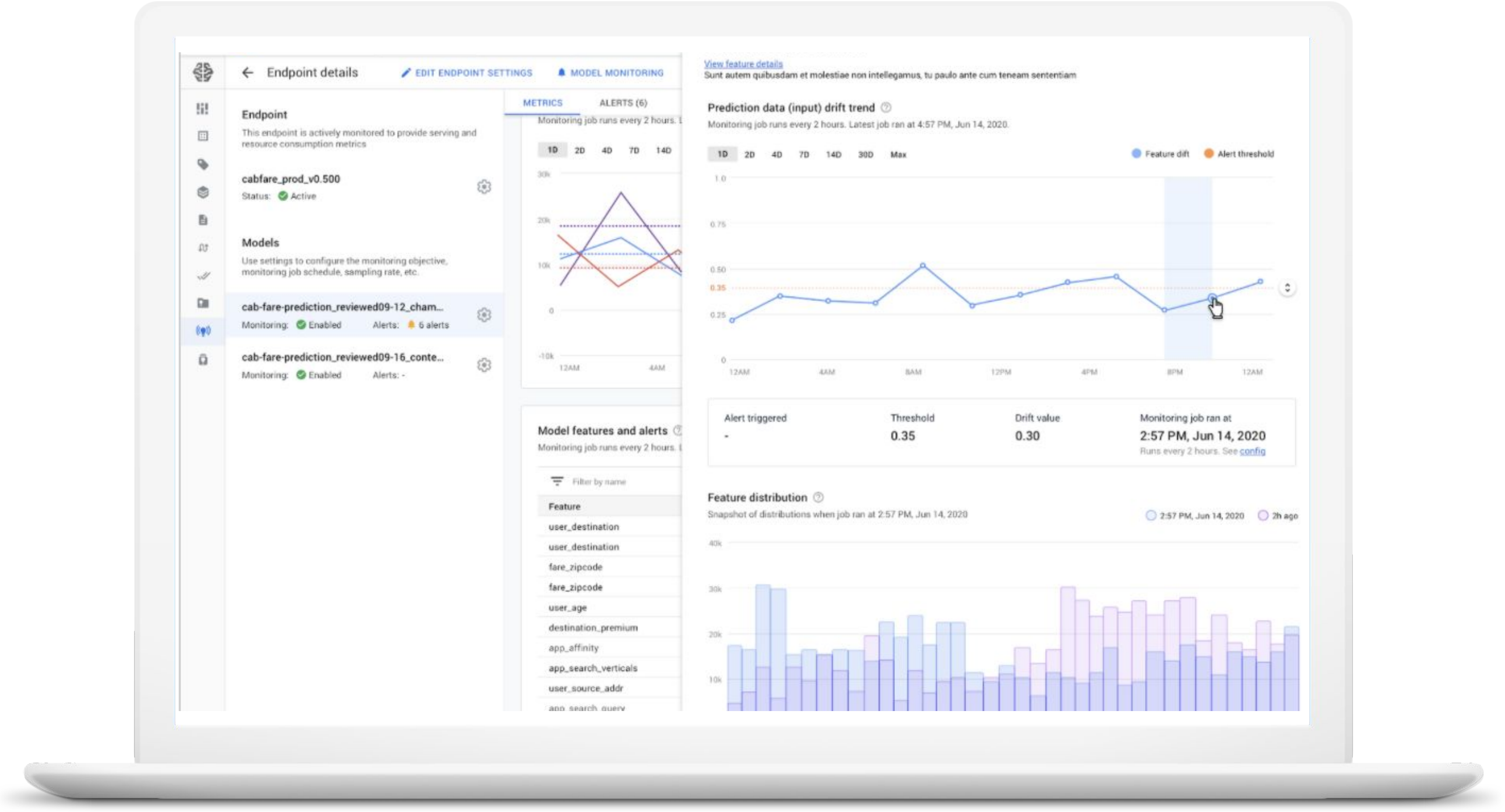
Preprocessed features

Train model

Model

BigQuery to process tabular data
Dataflow to process unstructured data

Best practices: Data preprocessing



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Monitoring job runs every 2 hours. L

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Dataflow

Use Dataflow to process unstructured data.

TensorFlow Extended

Use TensorFlow Extended when leveraging TensorFlow ecosystem.

Data preprocessing with BigQuery

> **BigQuery**
>
> Use BigQuery to process tabular data.

If you're using tabular data, use BigQuery for data processing and transformation steps.

When you're working with ML, use BigQuery ML in BigQuery. Perform the transformation as a normal BigQuery query, then save the results to a permanent table.

Using managed datasets in Vertex AI

> **Managed datasets**
>
> Use managed datasets to link data to your models.

Managed datasets:

- Enable you to create a clear link between your data and custom-trained models,
- Provide descriptive statistics and automatic or manual splitting into train, test, and validation sets.
- Are not required to use Vertex AI.

Transforming unstructured data with Dataflow

Dataflow

Use Dataflow to process unstructured data.

Use Dataflow to convert the unstructured data into binary data formats like TFRecord, which can improve performance of data ingestion during training.

If you need to perform transformations that are not expressible in Cloud SQL or are for streaming, you can use a combination of Dataflow and the pandas library.

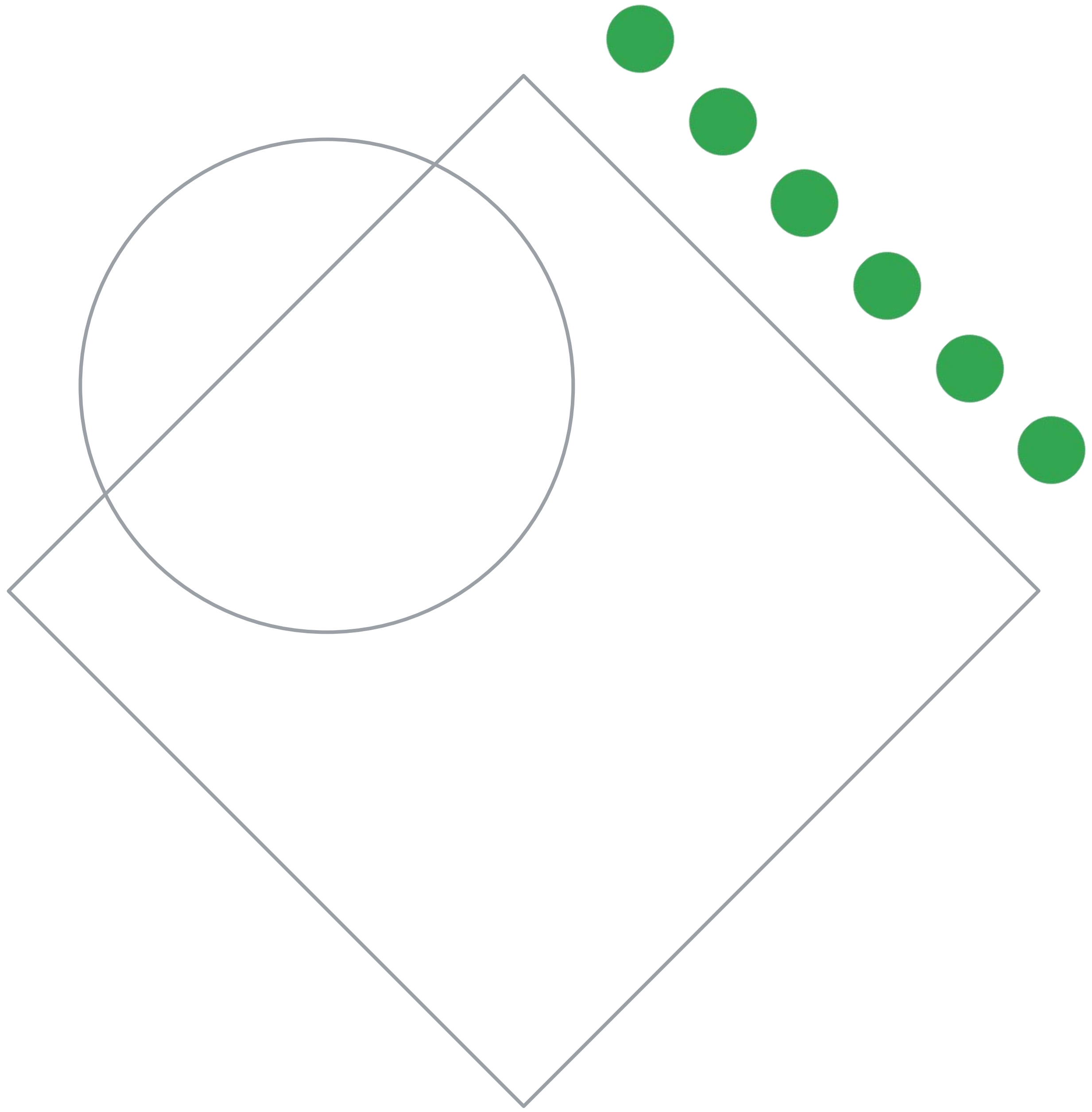
TensorFlow Extended

> **TensorFlow Extended**
>
> Use TensorFlow Extended when leveraging TensorFlow ecosystem.

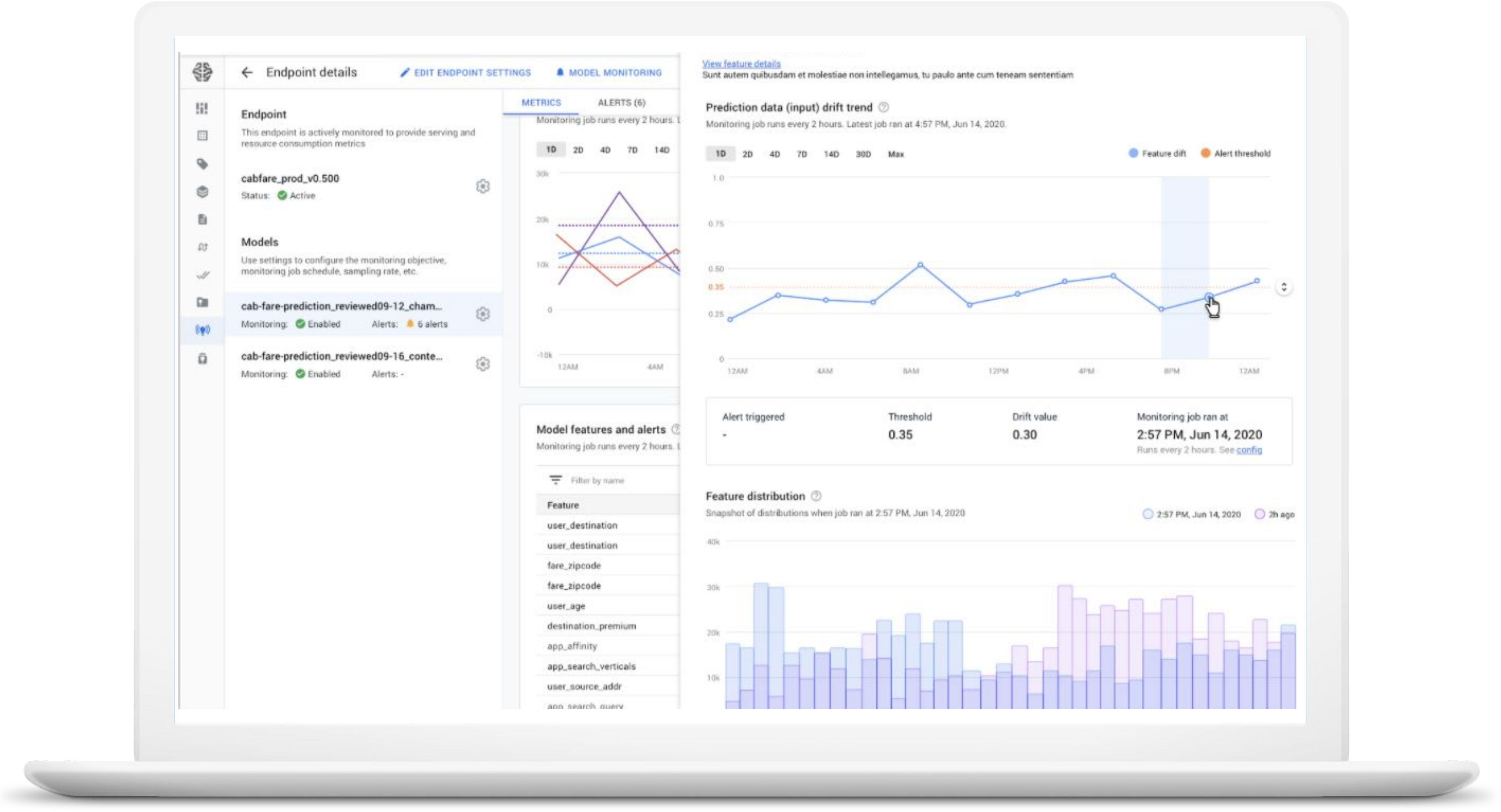
If you're using TensorFlow for model development, use TensorFlow Extended to prepare your data for training.

TensorFlow Transform is the TensorFlow component that enables defining and executing a preprocessing function to transform your data.

Best practices for ML environment setup



Best practices: ML environment setup



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app_search_query

Feature distribution

Snapshot of distributions when job ran at 2:57 PM, Jun 14, 2020

Workbench Notebooks

Use for development and experimentation. Create NB for each team member. Use Vertex SDK for Python.

Security

Secure PII in Notebooks.

Data & model

Store prepared data and model in same project.

Optimize performance & cost

Optimize performance and cost.

Workbench Notebooks

> **Workbench Notebooks**
> Use for development and experimentation. Create NB for each team member. Use Vertex SDK for Python

Use Notebooks for experimentation and development, including writing code, starting jobs, running queries, and checking status.

Create a new notebook instance for each member of your data science team.

Secure PII in Notebooks

Security

Secure PII in Notebooks

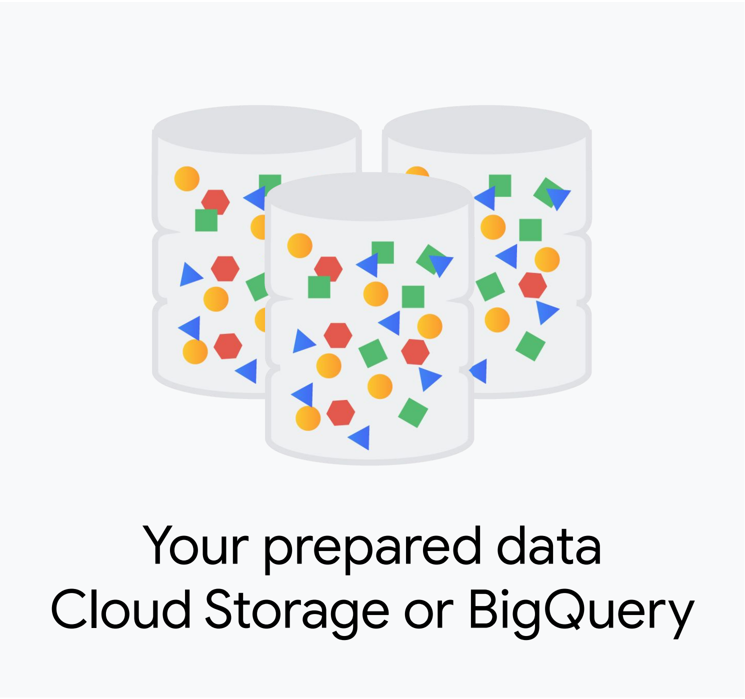
Apply data governance and security policies to help protect your Notebooks that contain personally identifiable information (PII) data - see Notebooks security blueprint: Protecting PII data guide.

Best practices: ML environment setup

Data & model

Store prepared data and model in same project.

Your Google Cloud project



Access all of the datasets required for modeling. Store prepared data in your Google Cloud project.

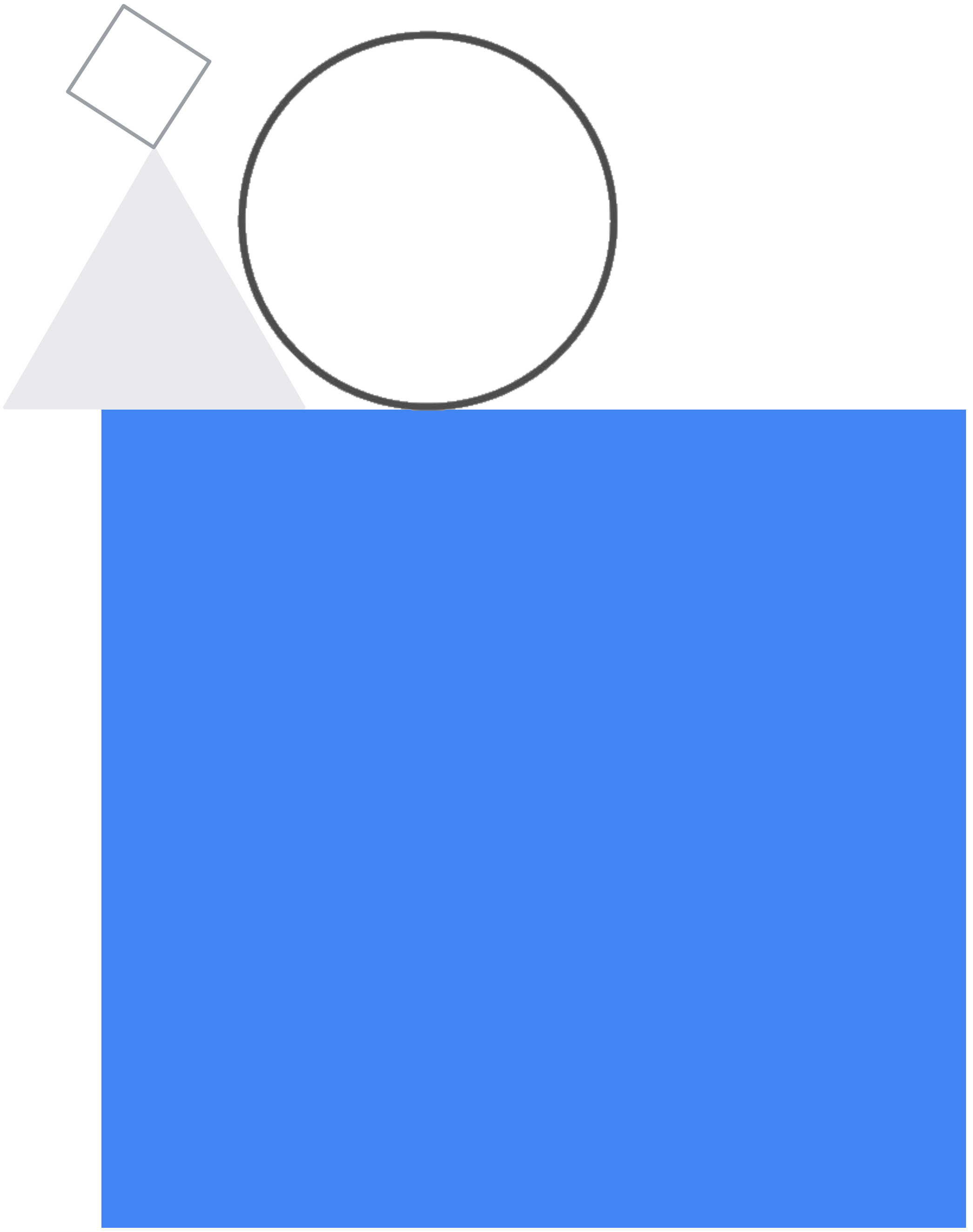
However, different parts of your organization might store their data in different projects, then rely on raw data from different projects.

Best practices: ML environment setup

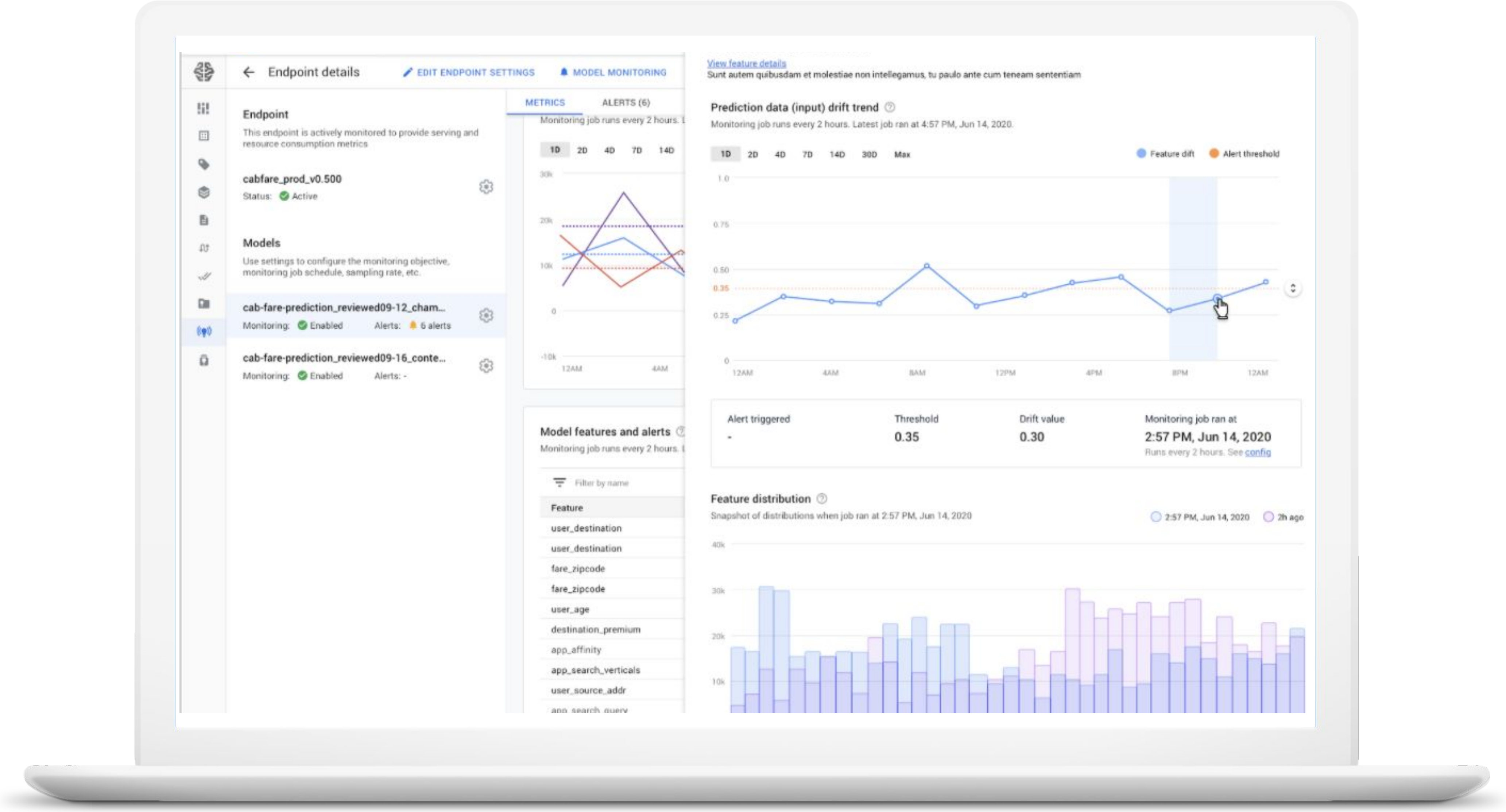
> Optimize performance & cost
>
> Optimize performance and cost.

Enhancing the performance and decreasing the cost of your machine learning workloads is a comprehensive subject, and out of scope for this course.

Best practices for ML model deployment and serving



Best practices:
Model deployment and serving



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View feature details

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Feature distribution

Snapshot of distributions when job ran at 2:57 PM, Jun 14, 2020

Machine type

Specify the number and type of machines you need.

Model inputs

Plan inputs to the model.

Automatic scaling

Turn on automatic scaling.

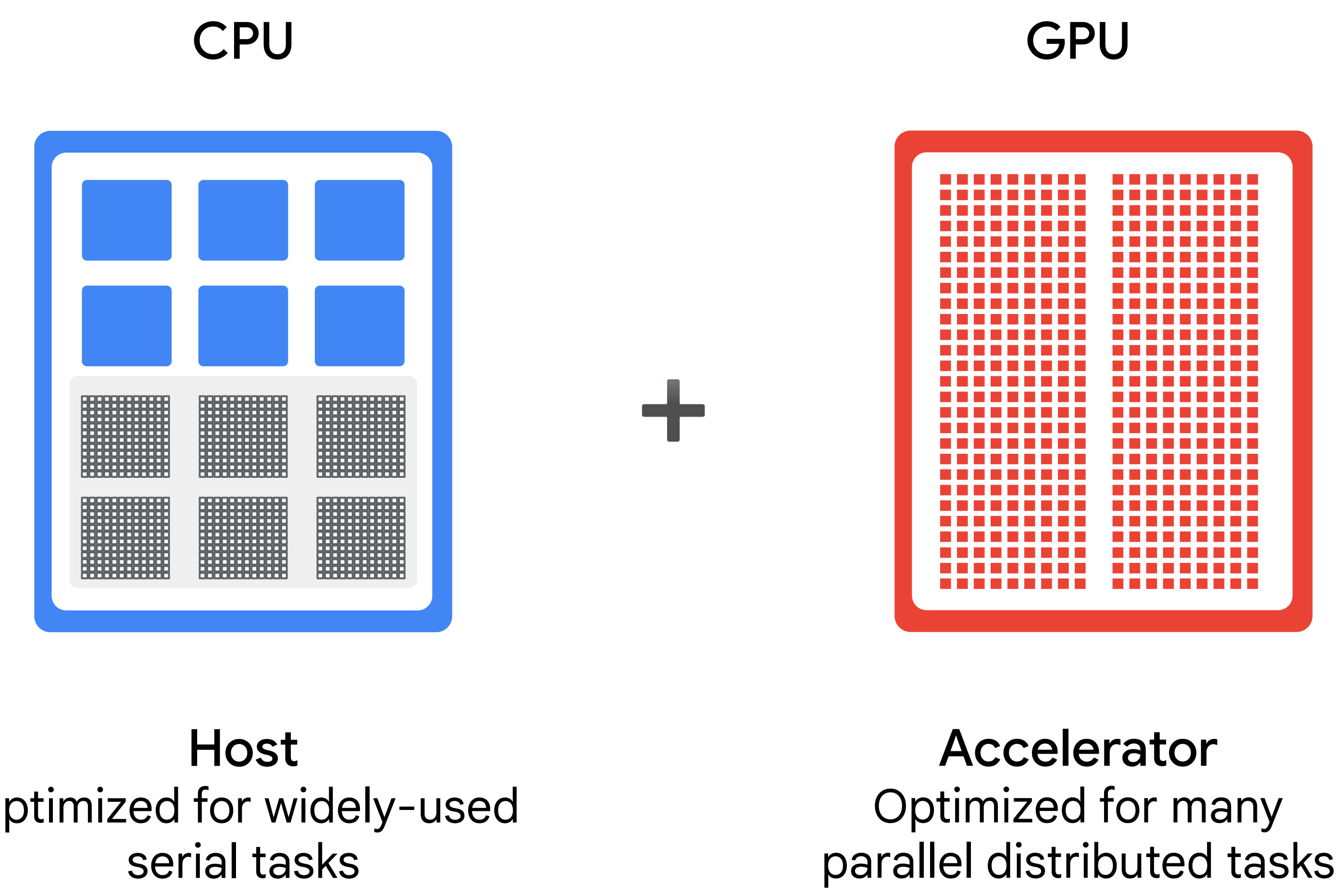
Specify performance requirements

Define what is good and bad performance.

Best practices: Model deployment and serving

Machine type

Specify the number and type of machines you need.


CPU
GPU
+
Host
Optimized for widely-used serial tasks
Accelerator
Optimized for many parallel distributed tasks

To deploy your model for prediction, choose hardware that is appropriate for your model, like different central processing unit (CPU) virtual machine (VM) types or graphics processing unit (GPU) types.

Best practices: Model deployment and serving

Model inputs

Plan inputs to the model.

If you're using batch prediction you can fetch data from the data lake, or from Vertex AI Feature Store batch serving API.

If you are using online prediction, send input instances to the service and it returns your predictions in the response.

Best practices: Model deployment and serving

Automatic scaling

Turn on automatic scaling

Turn on automatic scaling by setting minimum and maximum nodes.

Best practices: Model deployment and serving

> **Specify performance requirements**
>
> Define what is good and bad performance.
>
> When to retrain?

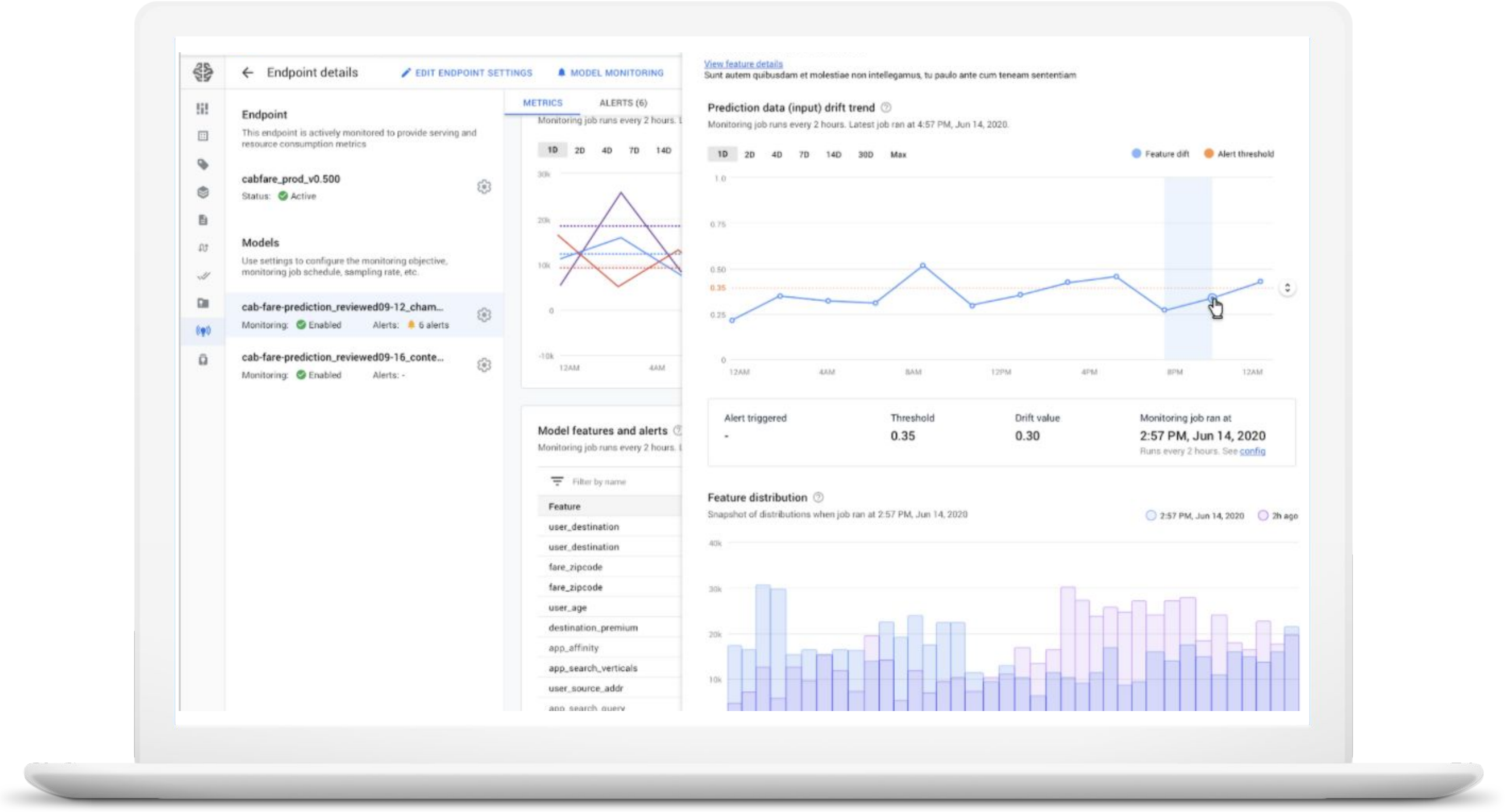
What constitutes “good” and “bad” performance?

What business metric do you want to optimize?

Should you retrain the model again before serving to capture “baseline” metrics?

Best practices for ML model monitoring

Best practices: Model monitoring



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Model features and alerts

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Skew

Use skew detection.

Data drift

Use feature attributions to detect data drift.

Alert thresholds

Fine tune alert thresholds.

Model inputs

Track model inputs.

Best practices: Model monitoring

> **Skew**
>
> Use skew detection.

Set up the model monitoring job by providing a pointer to the training data that you used to train your model.

If you do not have access to the training data, turn on drift detection so that you'll know when the inputs change over time.

Best practices: Model monitoring

Drift Detection

Look for drift in production data.

Drift occurs when the statistical properties of the inputs and the target, which the model is trying to predict, change over time in unforeseen ways.

This causes problems because the predictions could become less accurate as time passes.

Best practices: Model monitoring

Alert thresholds

Know when skew or drift occurs in your data.

Tune threshold alerts, which are determined by the use case, the user's domain expertise, and by initial model monitoring metrics.

Best practices: Model monitoring

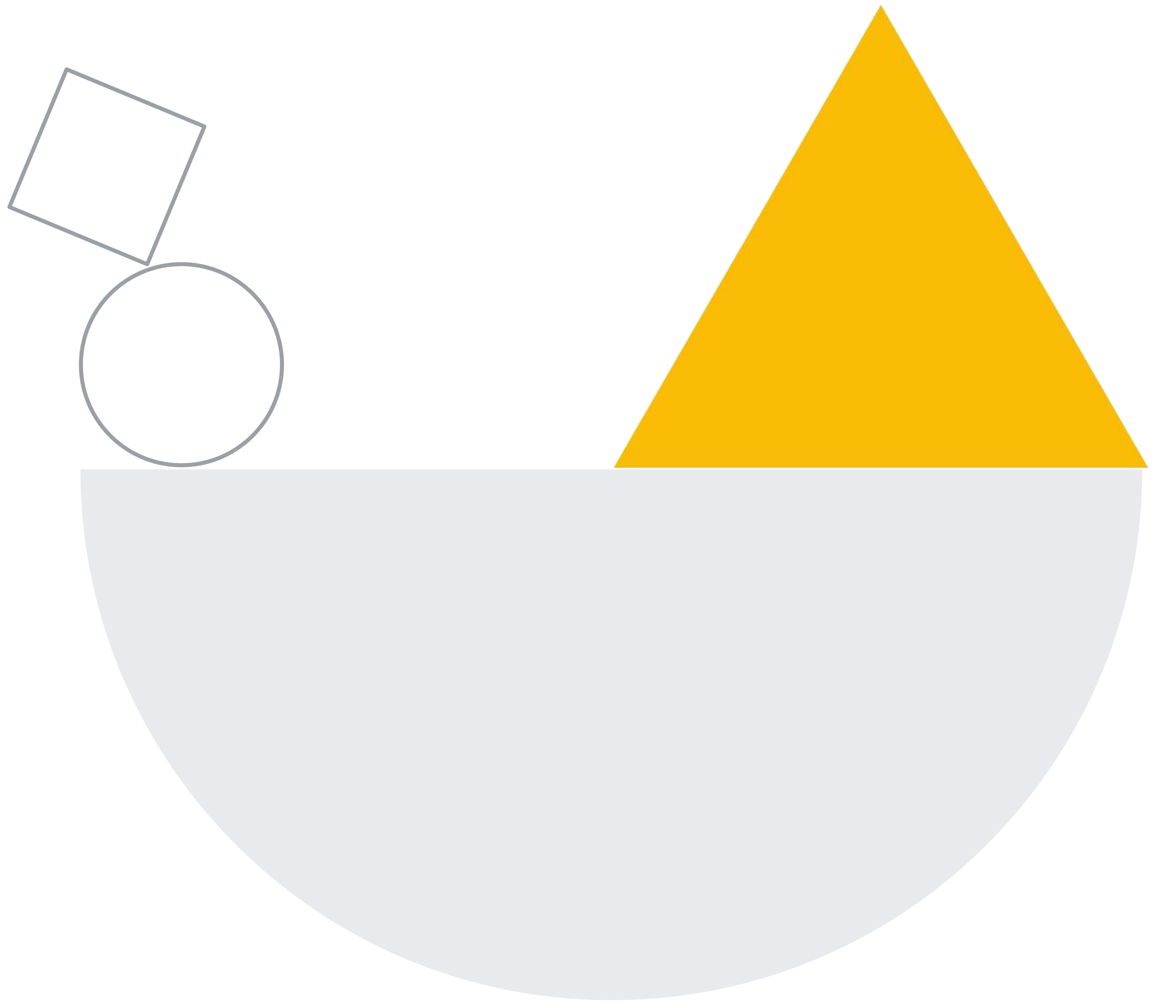
Model Inputs

How are you going to track inputs to the model?

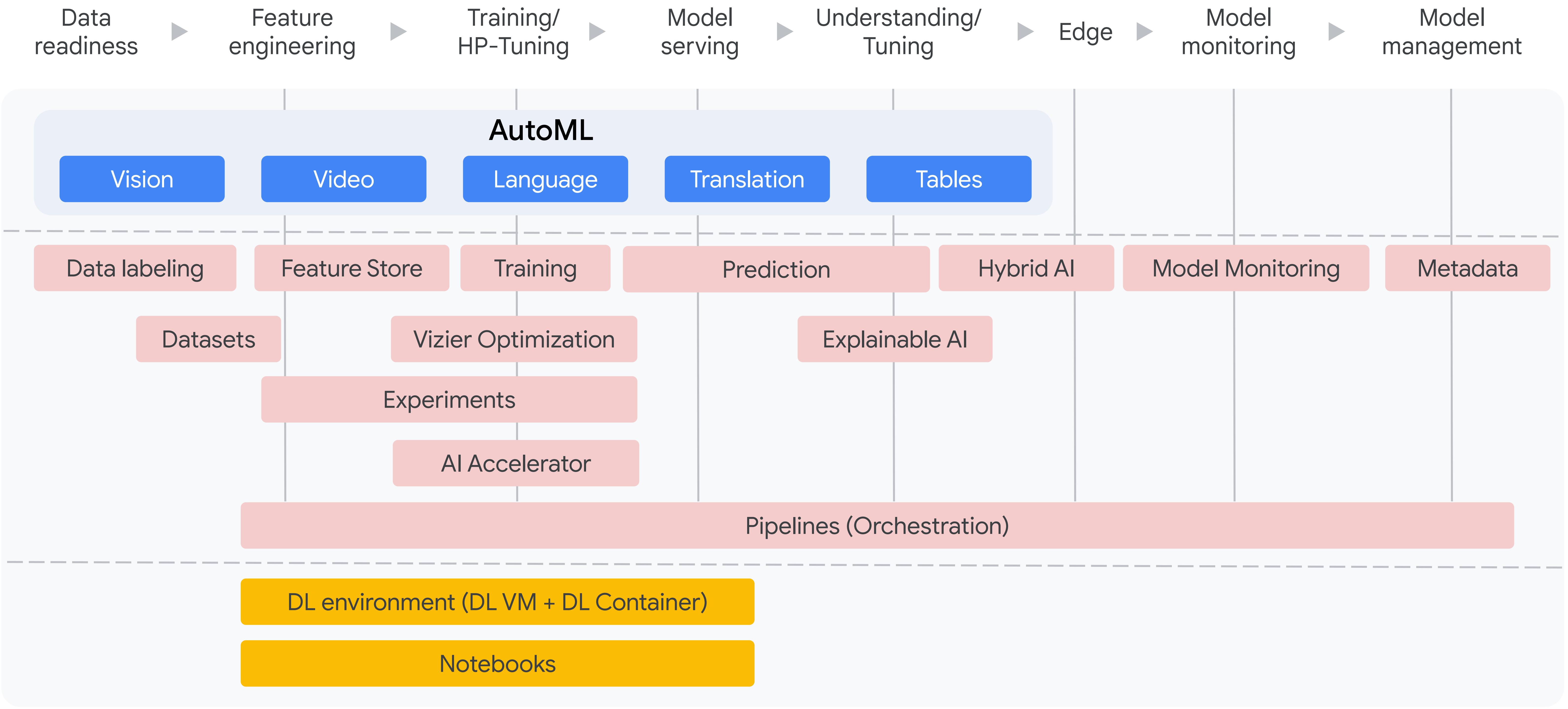
Determine how you're going to pass inputs to the model. If you're using batch prediction you can fetch data from the data lake, or from Vertex AI Feature Store batch serving API.

If you are using online prediction, you can send input instances to the service and it returns your predictions in the response.

Vertex AI Pipeline best practices



What's included in Vertex AI?



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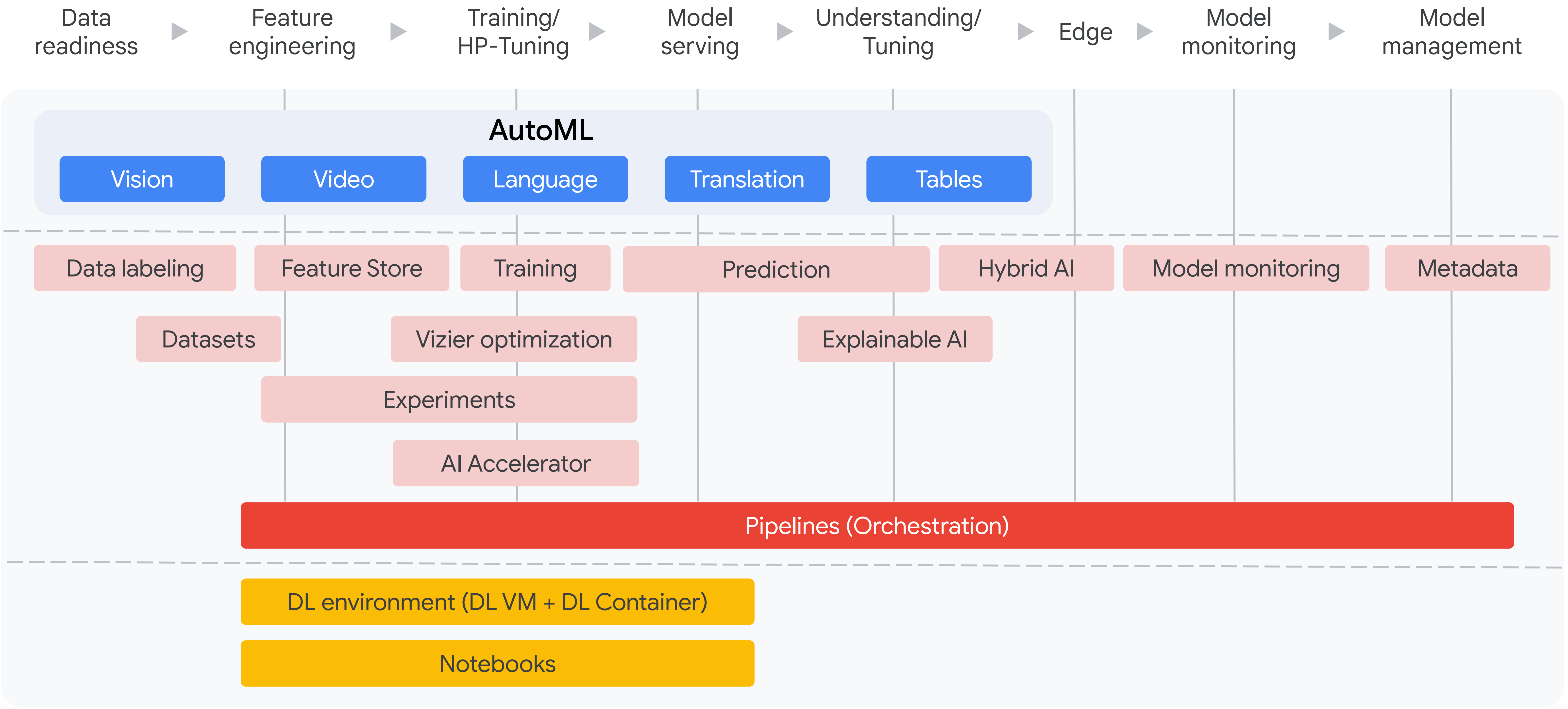
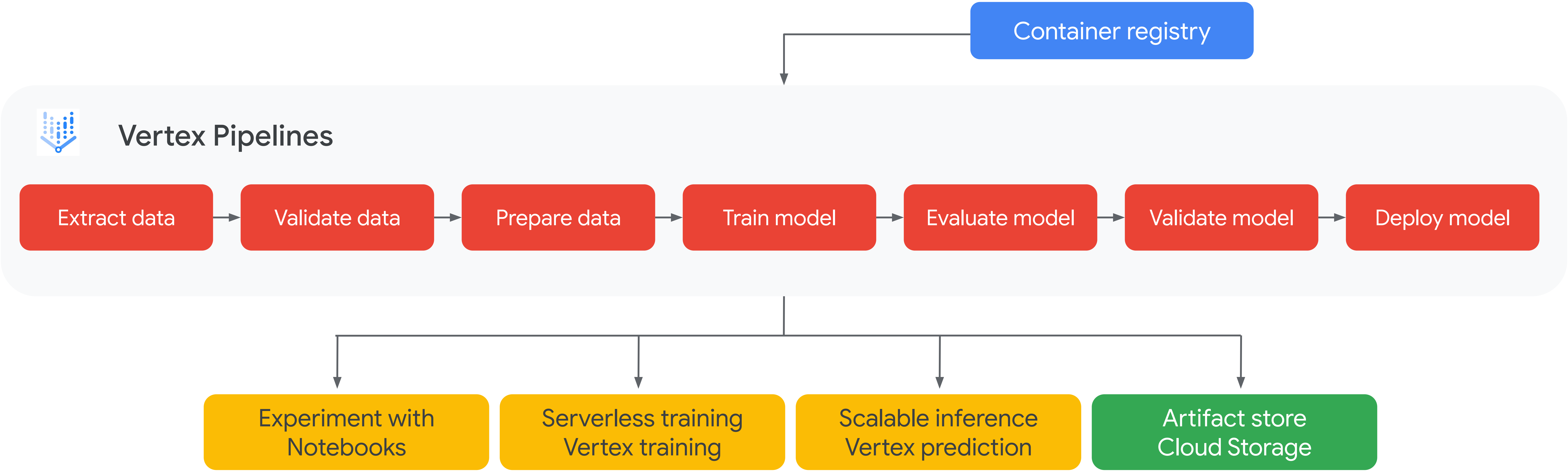
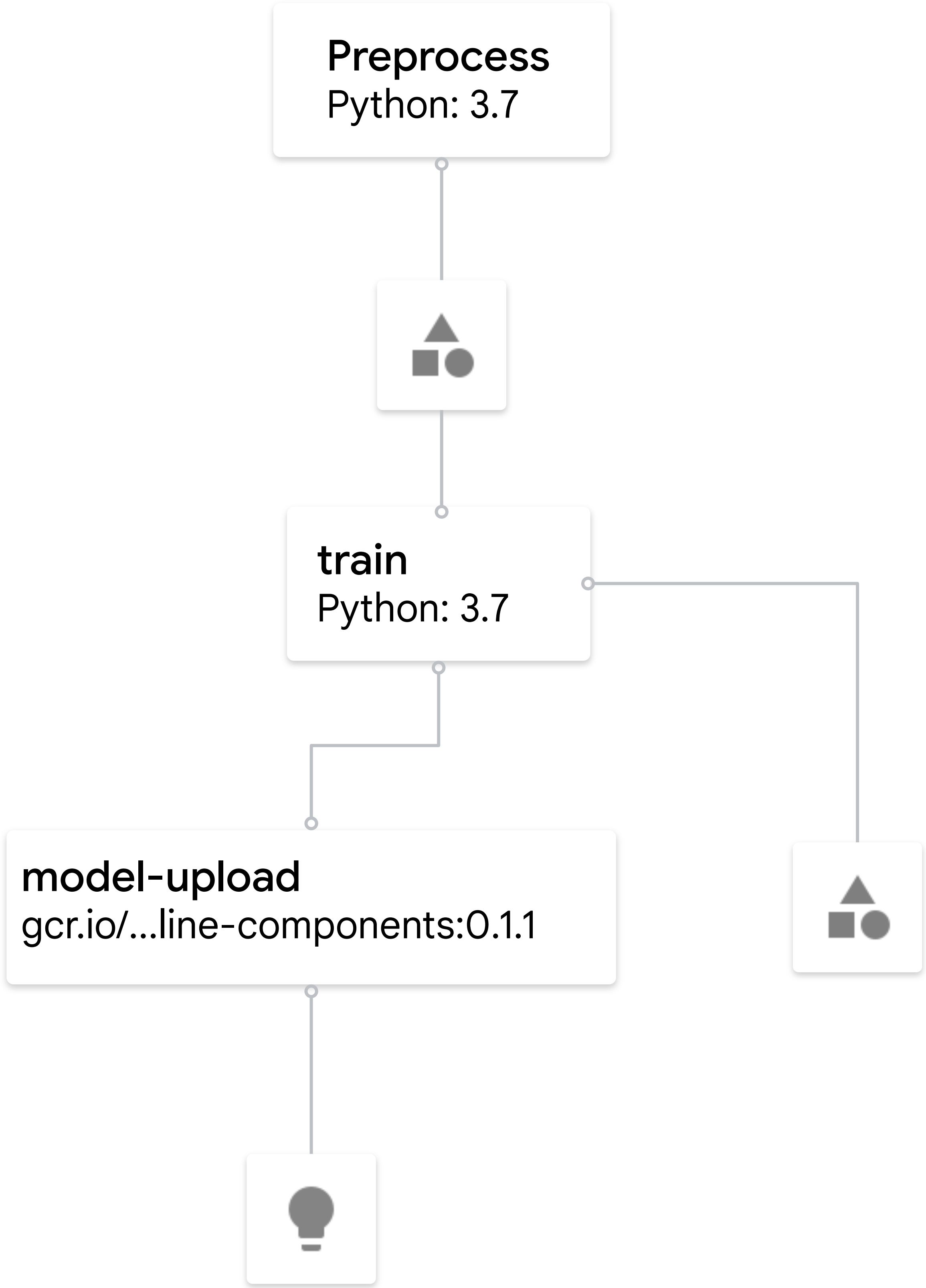


Pipelines automate the training and deployment of models

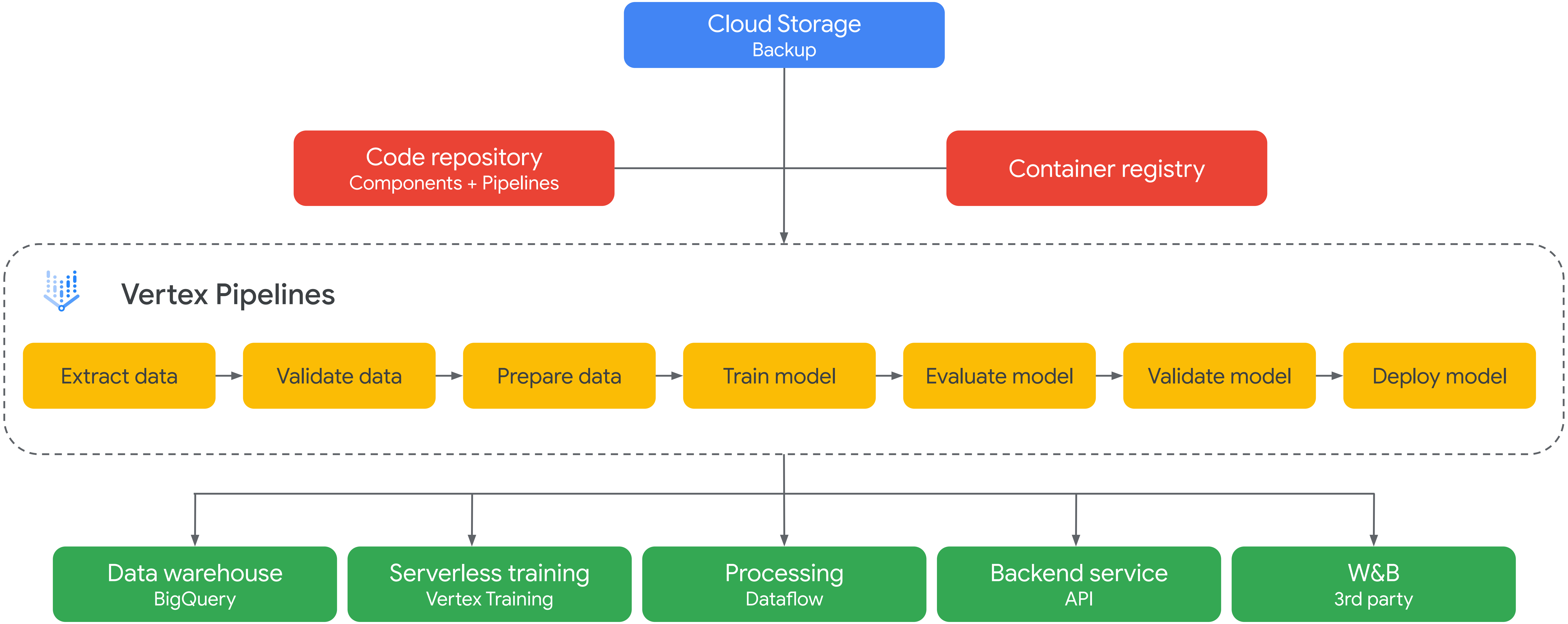

Container registry
Vertex Pipelines
Extract data
Validate data
Prepare data
Train model
Evaluate model
Validate model
Deploy model
Experiment with Notebooks
Serverless training Vertex training
Scalable inference Vertex prediction
Artifact store Cloud Storage

Pipeline

- A pipeline is composed of modular components
- A pipeline offers automation and orchestration
- Components are chained with dsl to form a pipeline



Supporting architecture



Cloud Storage
Backup

Code repository
Components + Pipelines

Container registry

Vertex Pipelines

Extract data → Validate data → Prepare data → Train model → Evaluate model → Validate model → Deploy model

Data warehouse
BigQuery

Serverless training
Vertex Training

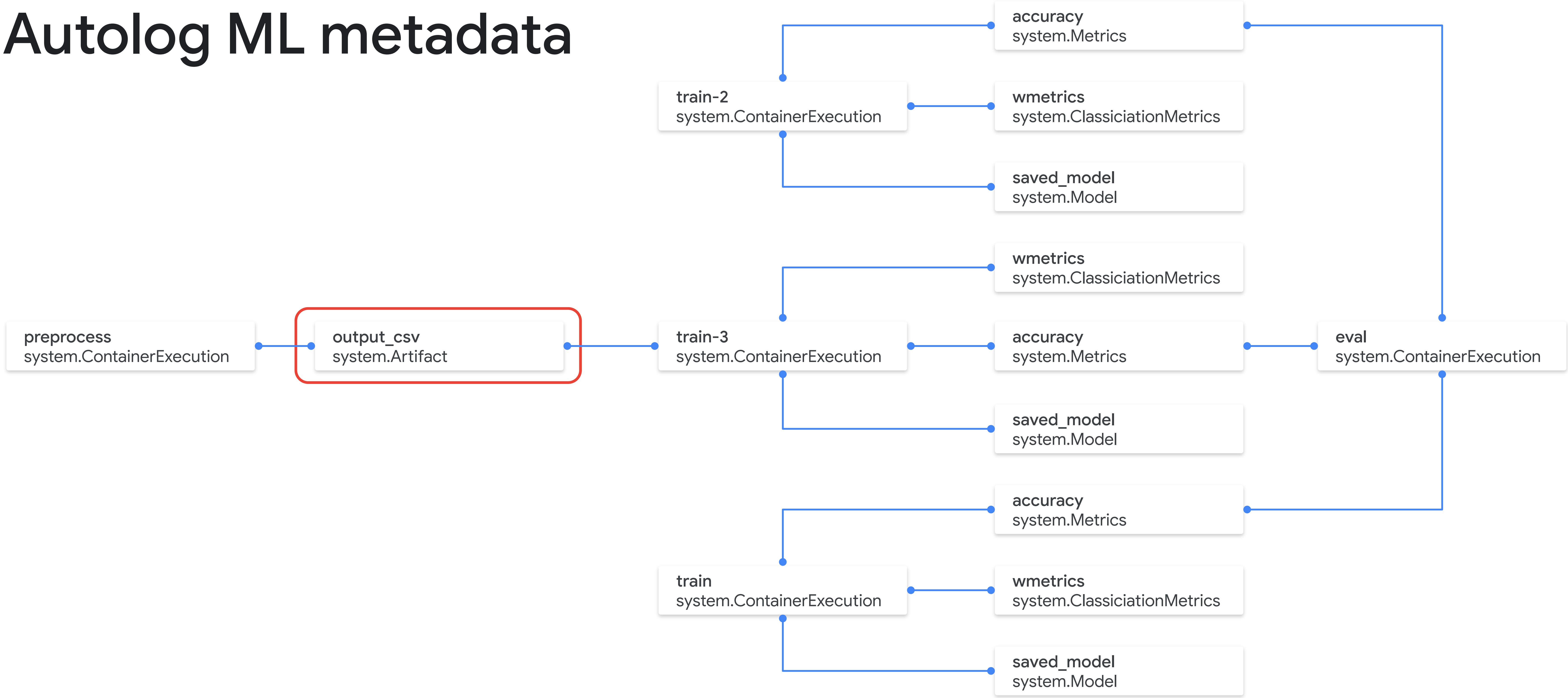
Processing
Dataflow

Backend service
API

W&B
3rd party

Data-rich formats

Autolog ML metadata



preprocess
system.ContainerExecution

output_csv
system.Artifact

train-2
system.ContainerExecution

accuracy
system.Metrics

wmetrics
system.ClassiciationMetrics

saved_model
system.Model

train-3
system.ContainerExecution

wmetrics
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wmetrics
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saved_model
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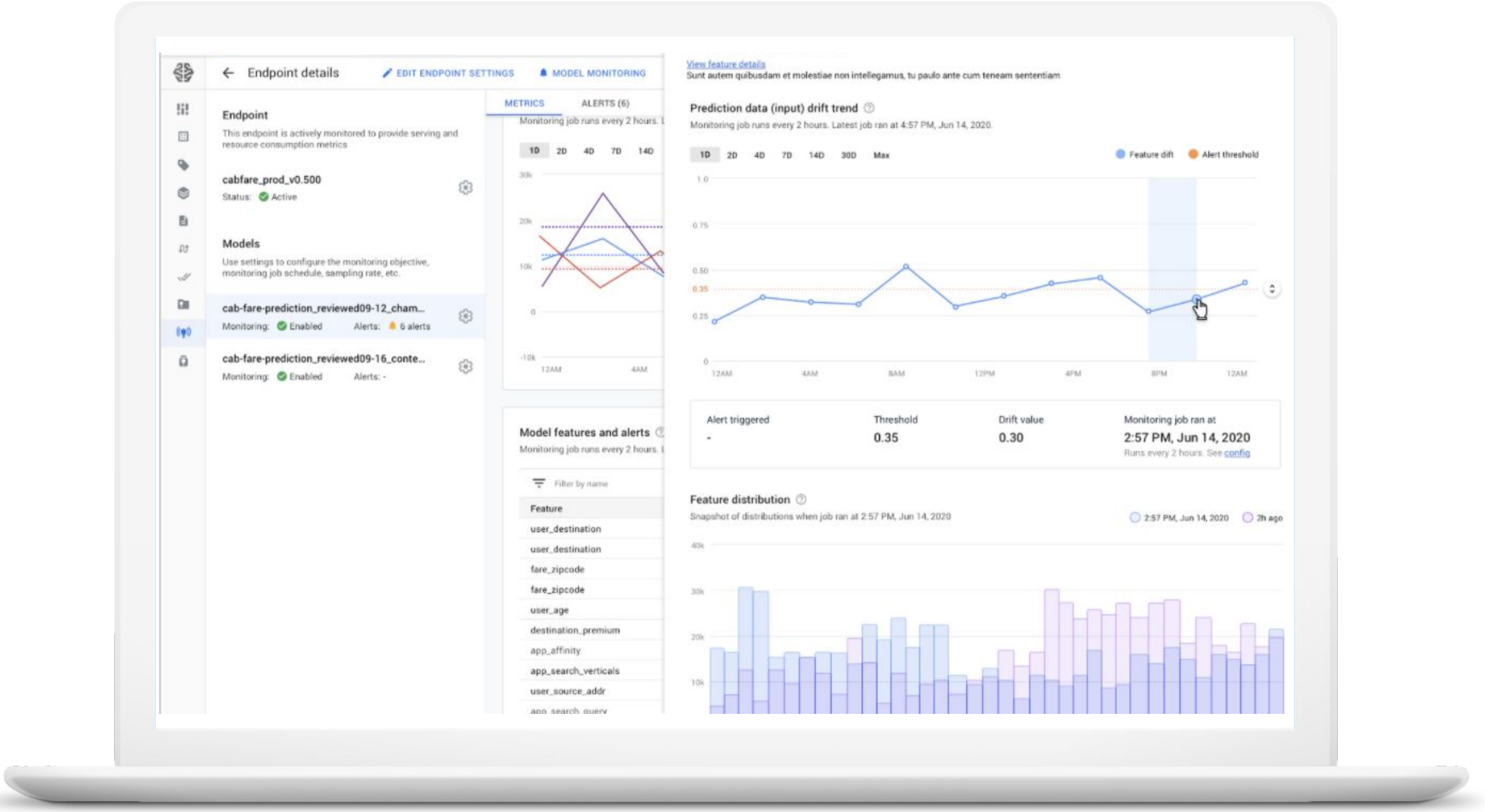
eval
system.ContainerExecution

Best practices: Vertex AI Pipelines



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Assess perfection

Why did a pipeline produce an especially accurate model?

Compare pipelines

Which pipeline run produced the most accurate model and parameters used?

System governance

Which version of your model is in production at a given time?

Pipeline SDK

Kubeflow SDK
TensorFlow Extended

Artifact organization best practices

Best practices: Artifact organization

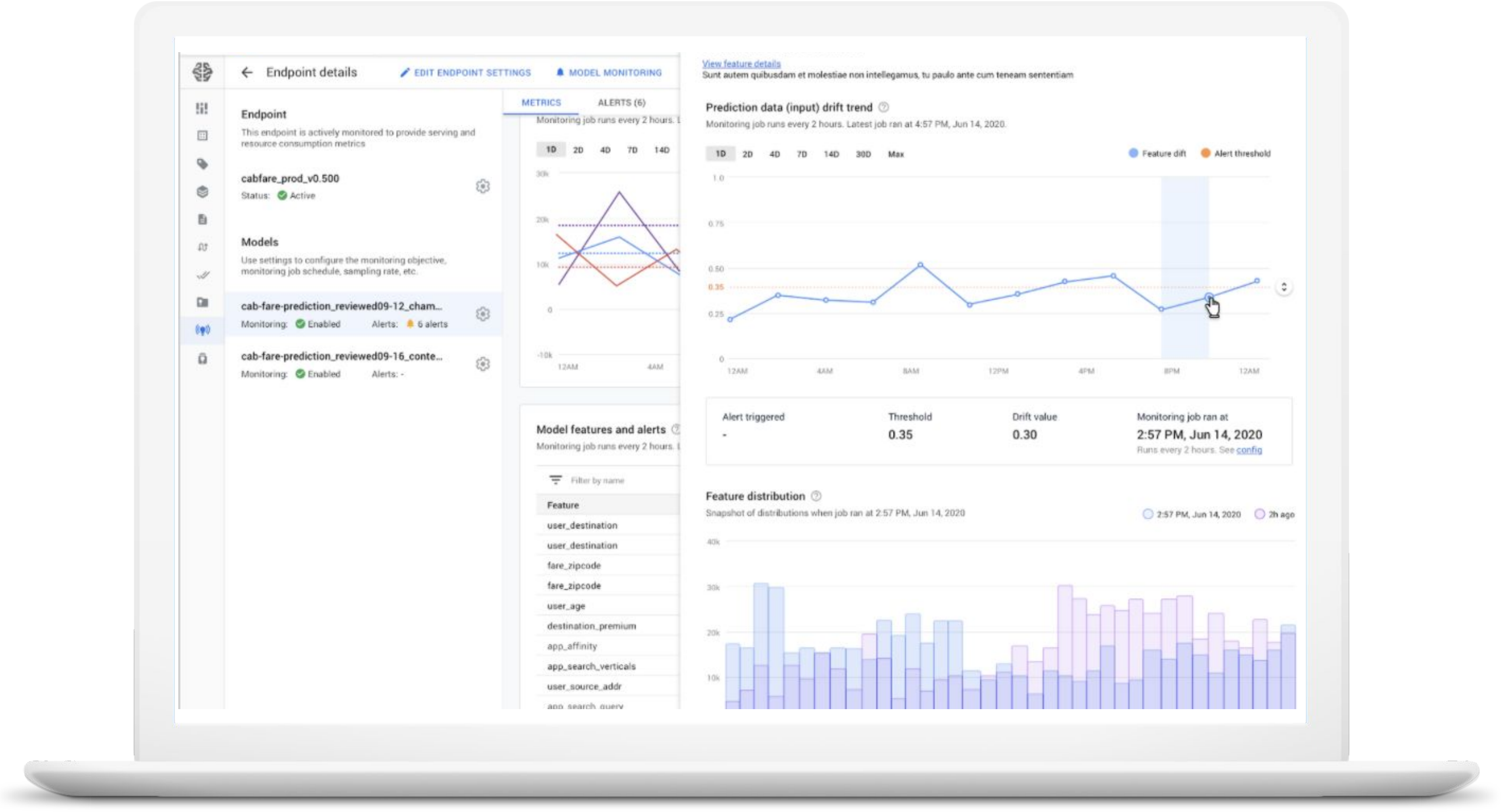
Artifact lineage describes all the factors that resulted in an artifact.

You can understand differences in performance or accuracy over several pipeline runs.

A model's lineage could include the following:

- The training, test, and evaluation data used to create the model.
- The hyperparameters used during model training.
- The code that was used to train the model.
- Metadata recorded from the training and evaluation process.
- Artifacts that descend from this model.

Best practices: Artifact organization



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Use settings to configure the monitoring objective, monitoring job schedule, sampling rate, etc.

cab-fare-prediction_reviewed09-12_cham...
Monitoring: Enabled   Alerts: 6 alerts

cab-fare-prediction_reviewed09-16_conte...
Monitoring: Enabled   Alerts: -

Monitoring job runs every 2 hours.

Model features and alerts

Monitoring job runs every 2 hours.

Feature
user_destination
user_destination
fare_zipcode
fare_zipcode
user_age
destination_premium
app_affinity
app_search_verticals
user_source_addr
app_search_query

View feature details
Sunt autem quibusdam et molestiae non intellegamus, tu paulo ante cum teneam sententiam

Prediction data (input) drift trend

Monitoring job runs every 2 hours. Latest job ran at 4:57 PM, Jun 14, 2020.

Alert triggered	Threshold	Drift value	Monitoring job ran at
-	0.35	0.30	2:57 PM, Jun 14, 2020 Runs every 2 hours. See config

Feature distribution

Snapshot of distributions when job ran at 2:57 PM, Jun 14, 2020

Artifacts are outputs resulting from each step in the ML workflow.

Artifacts

Organize your
ML model artifacts.

Git repo

Use a Git repo for pipeline
definitions and training code.

Best practices: Artifact organization

Git repo

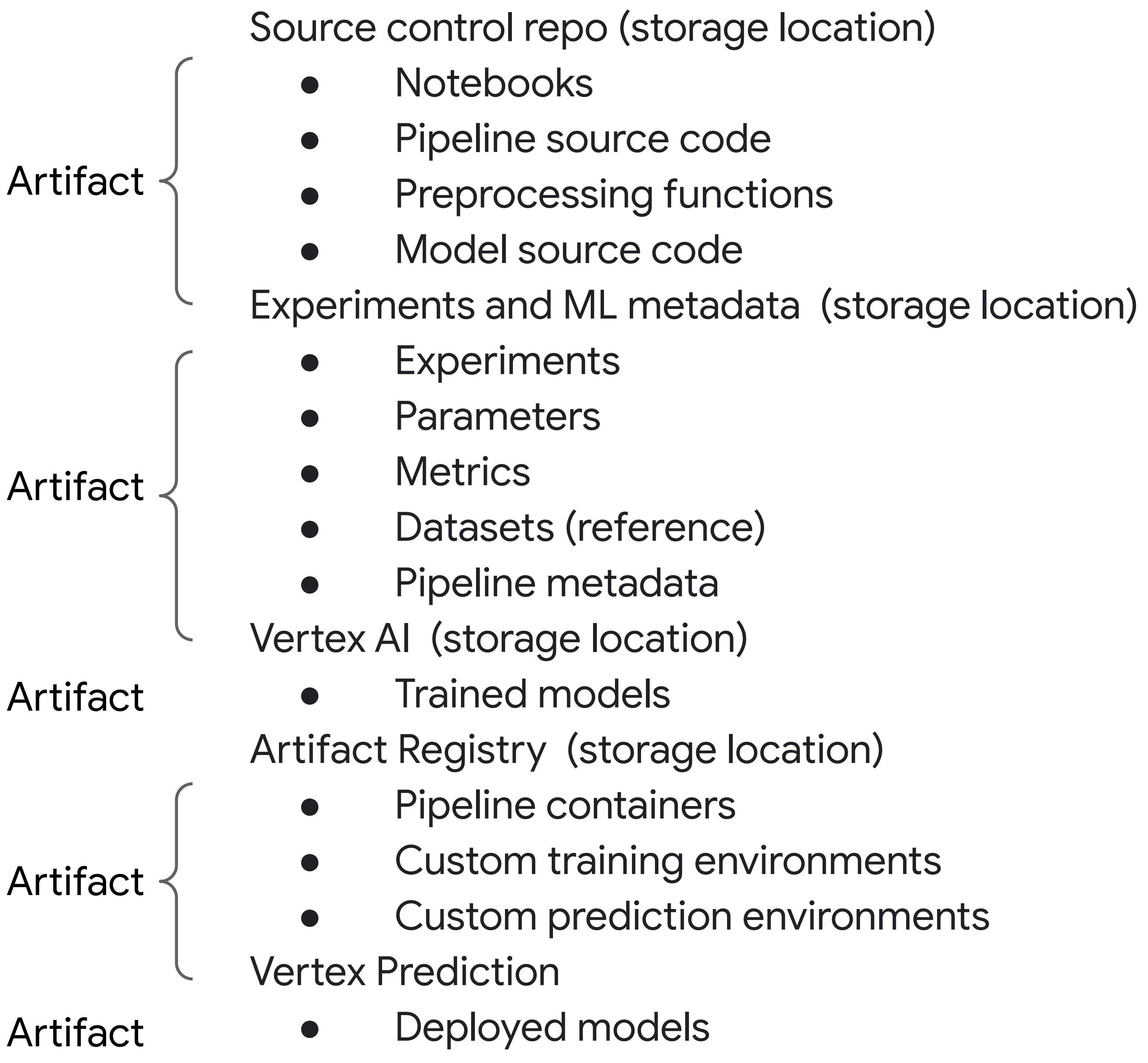
Use a Git repo for pipeline definitions and training code.

You can use Git to version control your ML pipelines and the custom components you build for those pipelines.

Best practices: Artifact organization

Git repo

Use a Git repo for pipeline definitions and training code



Source control repo (storage location)

Artifact

- Notebooks
- Pipeline source code
- Preprocessing functions
- Model source code

Experiments and ML metadata (storage location)

Artifact

- Experiments
- Parameters
- Metrics
- Datasets (reference)
- Pipeline metadata

Vertex AI (storage location)

Artifact

- Trained models

Artifact Registry (storage location)

Artifact

- Pipeline containers
- Custom training environments
- Custom prediction environments

Vertex Prediction

Artifact

- Deployed models