

# Slides That are used as screenshots in the github/statmike/vertex-ai-mlops repository

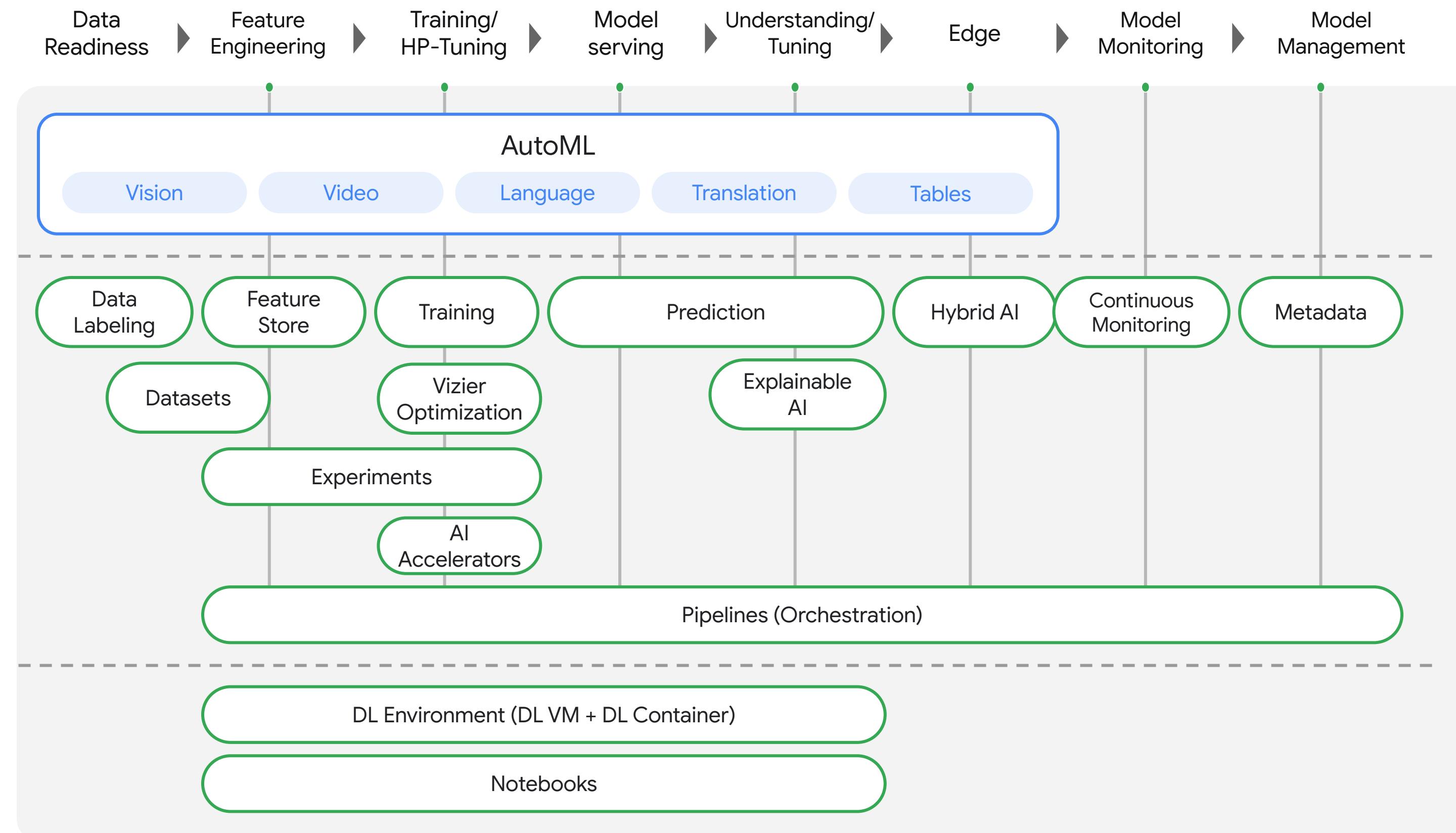
Notes:

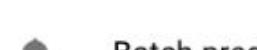
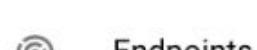
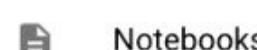
- Do not insert new slides or reorder without updating the notebooks. The slides are exported to numbered .png files that are referenced in the notebooks

Process

- Save as PDF
- Copy to `github/statmike/vertex-ai-mlops/architectures/slides`
- Convert PDF to PNG images
  - Use Notebook: `/architectures/Create Images.ipynb`
  - OUTPUT:
    - To `/architectures/slides`

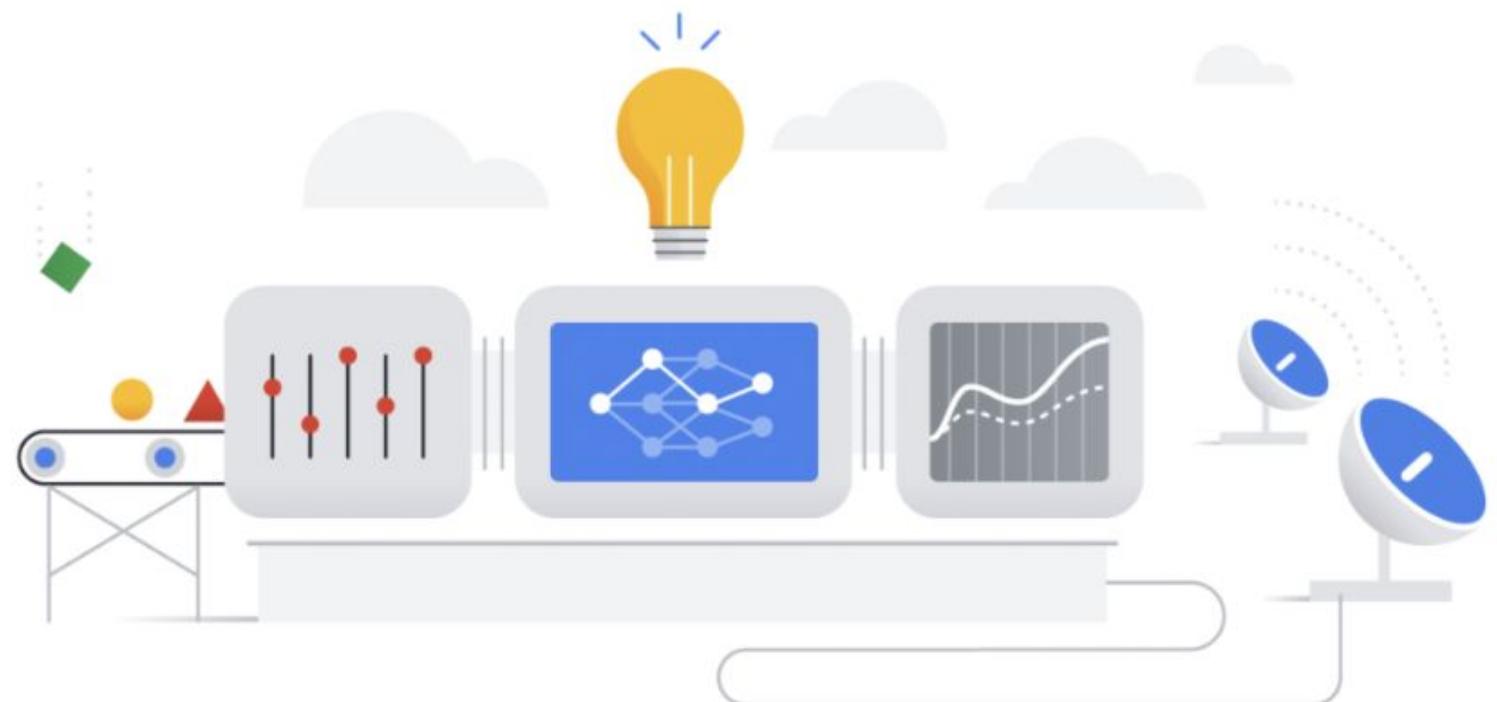
# Vertex AI Overview





## Get started with Vertex AI

Vertex AI empowers machine learning developers, data scientists, and data engineers to take their projects from ideation to deployment, quickly and cost-effectively. [Learn more](#)



Region

us-central1 (Iowa)



### Recent datasets

- ✓ 02c\_digits\_20210919213805 16 hours ago
- ✓ 02b\_digits\_20210919205707 20 hours ago
- ✓ 02a 4 days ago
- ✓ 02b\_digits\_20210916141540 4 days ago
- ✓ 02c\_digits\_20210916004500 5 days ago

[+ CREATE DATASET](#)

### Recent models

- ✓ 05f\_digits\_20210920145828 1 hour ago
- ✓ 05e\_digits\_20210920125450 3 hours ago
- ✓ 02c\_digits\_20210919213805 12 hours ago  
Average precision: 1
- ✓ 02b\_digits\_20210919205707 19 hours ago  
Average precision: 1
- ✓ 05c\_digits\_20210919214125-model 19 hours ago

[+ TRAIN NEW MODEL](#)

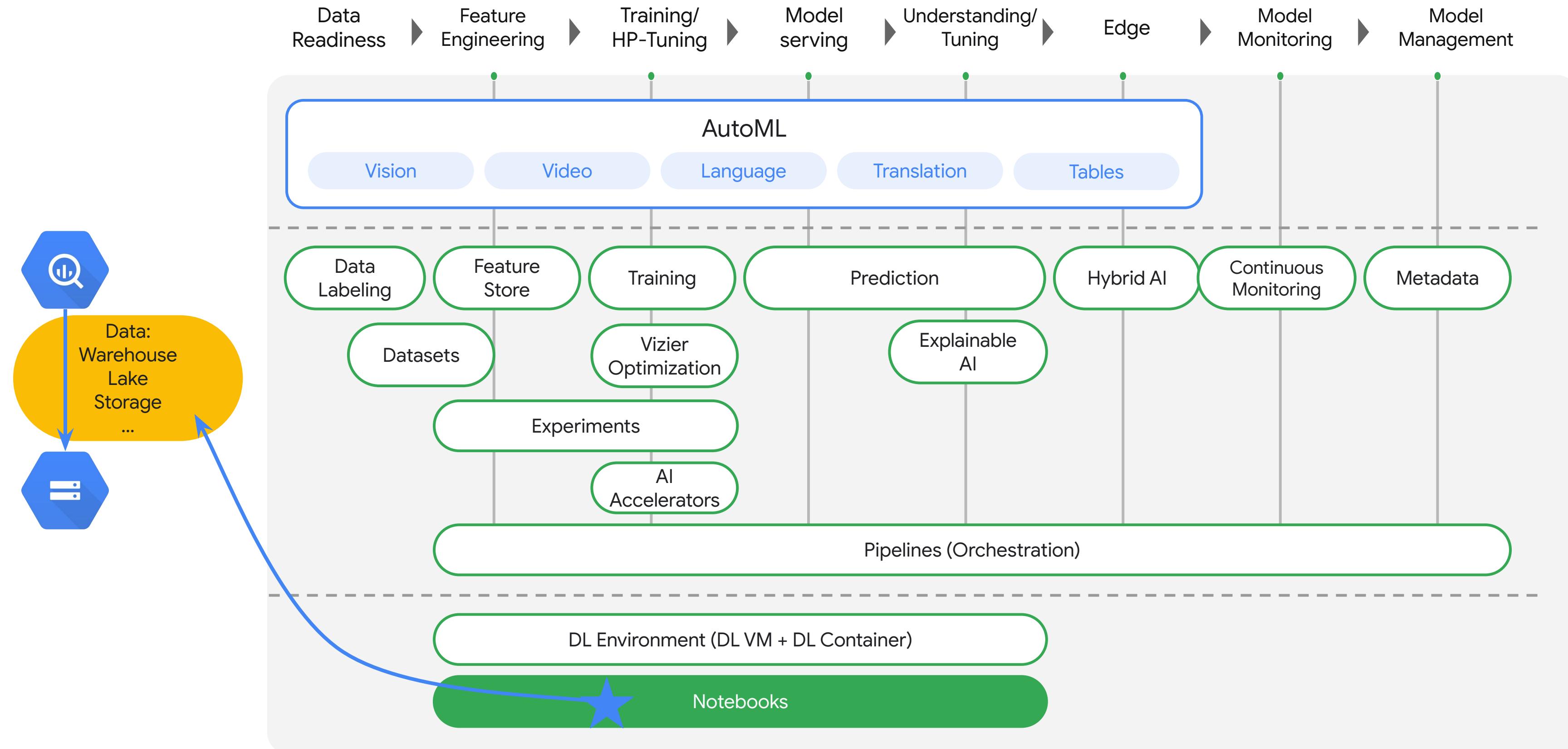
### Get predictions

After you train a model, you can use it to get predictions, either online as an endpoint or through batch requests

[+ CREATE BATCH PREDICTION](#)[Show debug panel](#)

# Notebook: 00

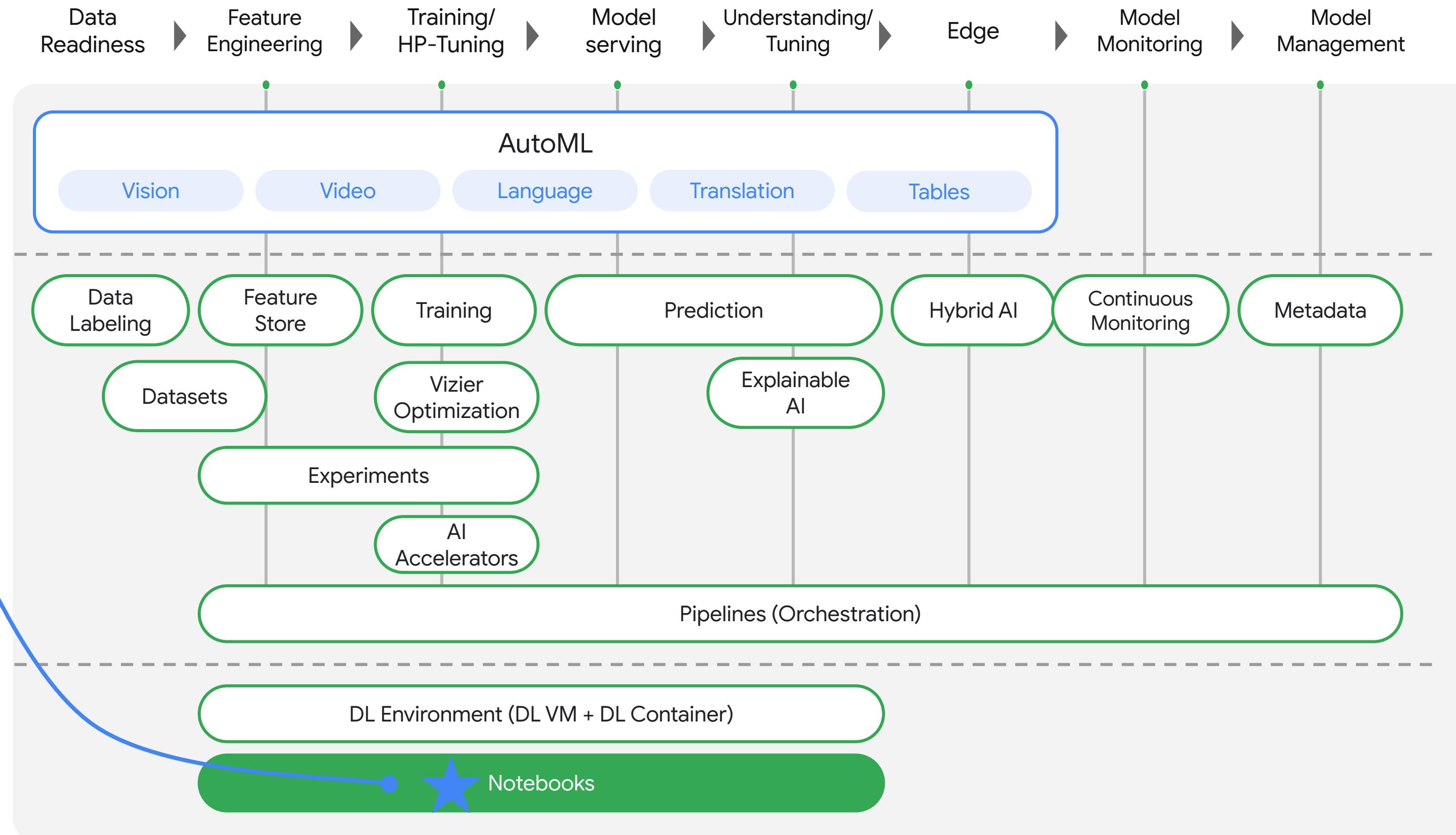
# Vertex AI Overview





# Notebook: 01

# Vertex AI Overview



# Google Cloud Platform

Vertex AI

Dashboard

Datasets

Features

Labeling tasks

Notebooks

Pipelines

Training

Experiments

Models

Endpoints

Batch predictions

Metadata

Marketplace

The screenshot shows a Jupyter Notebook environment within Google Colab. The notebook title is "01 - BigQuery - Table Data Source". The content discusses using BigQuery to load and prepare data for machine learning, listing prerequisites (Environment Setup) and an overview of BigQuery setup, table creation, and data loading from GCS. A large yellow arrow points from the "Notebooks" menu in the sidebar to the "01 - BigQuery - Table Data Source" tab in the notebook interface.

**01 - BigQuery - Table Data Source**

Use BigQuery to load and prepare data for machine learning:

**Prerequisites:**

- 00 - Environment Setup

**Overview:**

- Setup BigQuery
  - Create a Dataset
    - Use BigQuery Python Client
  - Create Tables
    - Copy from another Project:Dataset
      - SQL with BigQuery
    - Load data from GCS
      - BigQuery Python
  - Prepare Data For Analysis
    - Run SQL Queries to pi

**Resources:**

- Python Client For Google BigQ
- Download BigQuery Data to Pa
- Query Template Notebooks

0 19 Git: idle Python 3 | Idle

File Edit View Run Kernel Git Tabs Settings Help

Launcher 01 - BigQuery - Table Data git Python 3

00 - Environme... 3 days ago

01 - BigQuery - Table Data 3 days ago

02a - Vertex AI ... 4 days ago

02b - Vertex AI ... 8 hours ago

02c - Vertex AI ... 8 hours ago

03a - BigQuery ... 4 days ago

03b - Vertex AI ... 8 hours ago

04a - Vertex AI ... 8 hours ago

05 - Vertex AI >... 20 hours ago

05a - Vertex AI ... 8 hours ago

05b - Vertex AI ... 4 hours ago

05c - Vertex AI ... 4 hours ago

05d - Vertex AI ... 4 hours ago

05e - Vertex AI ... 3 hours ago

05f - Vertex AI ... an hour ago

06 - Vertex AI >... 4 days ago

07 - Vertex AI >... 4 days ago

readme.md 5 days ago

XX - Cleanup.ip... 5 days ago

FEATURES & INFO SHORTCUT DISABLE EDITOR TABS

Explorer + ADD DATA

Type to search

Viewing pinned projects.

statmike-mlops

digits

Models (1)

digits

digits\_featurestore\_import

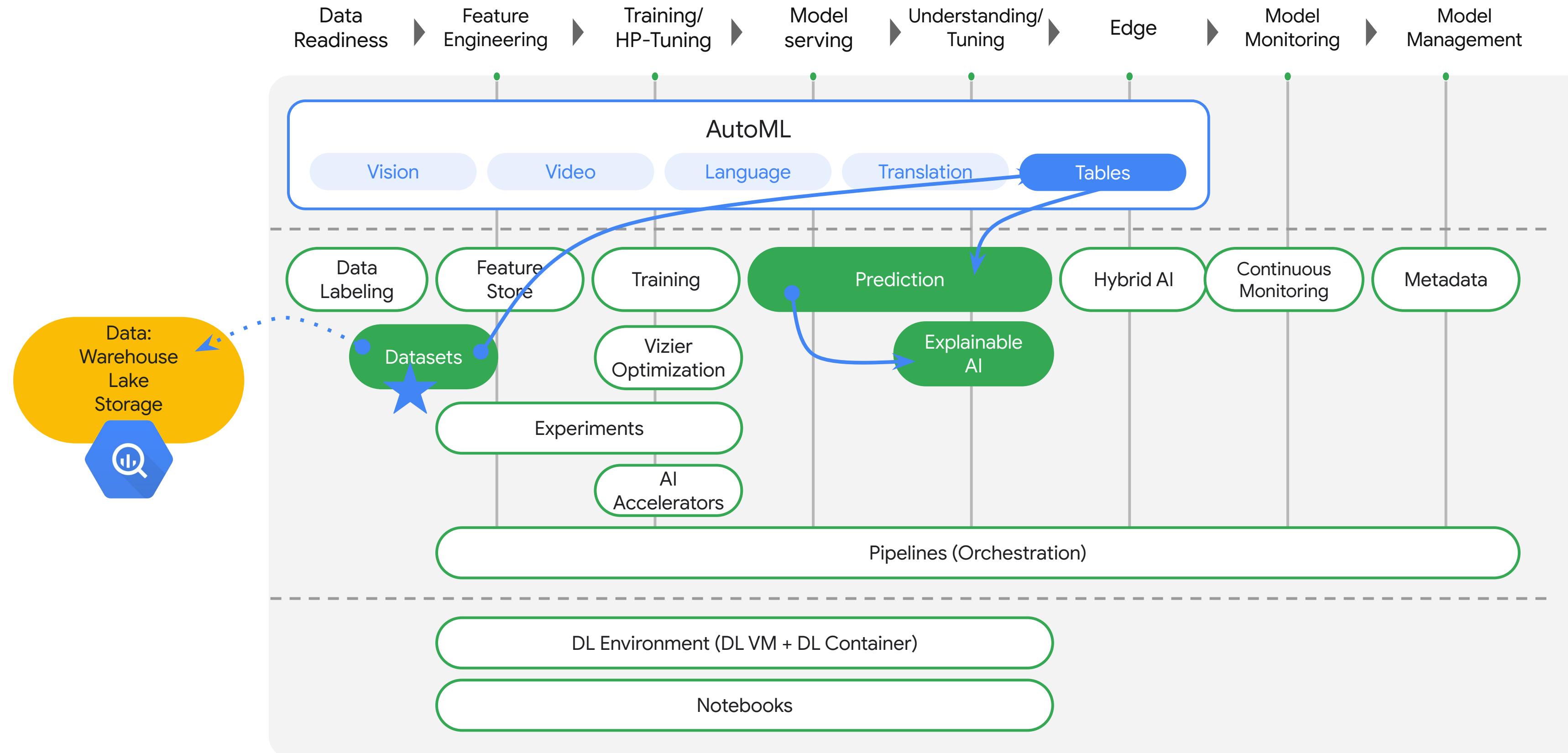
digits\_fs\_training

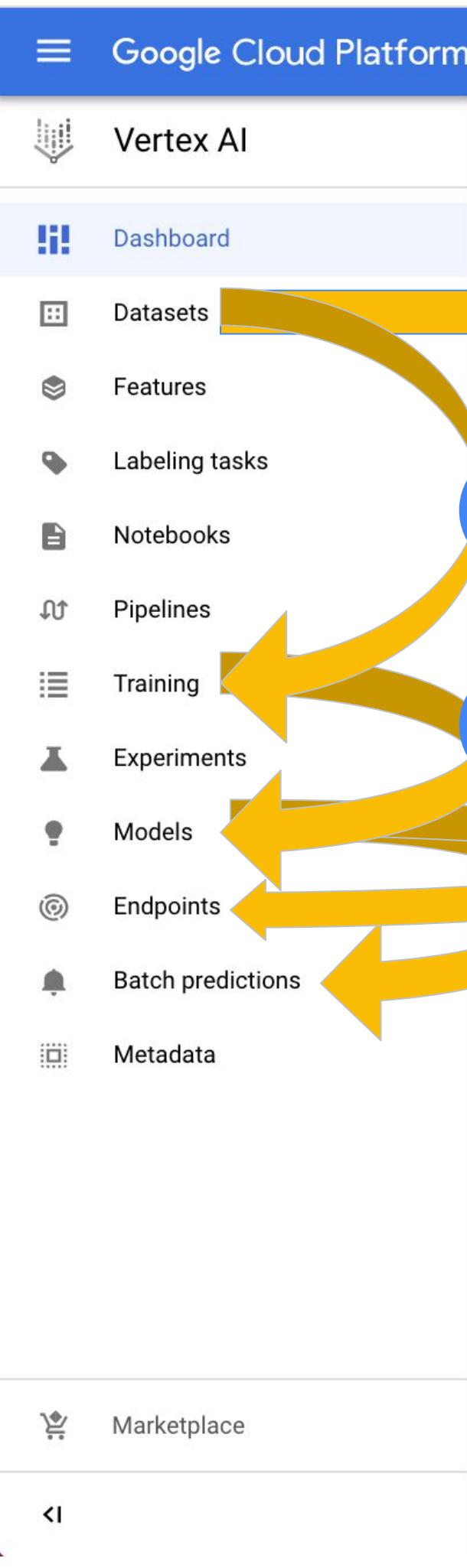
digits\_prepended

Row	p0	p1	p2	p3	p4	p5	p6	p7	p8	p
1	0.0	5.0	16.0	15.0	5.0	0.0	0.0	0.0	0.0	1
2	0.0	5.0	16.0	12.0	1.0	0.0	0.0	0.0	0.0	1
3	0.0	5.0	15.0	16.0	6.0	0.0	0.0	0.0	0.0	1
4	0.0	4.0	15.0	15.0	8.0	0.0	0.0	0.0	0.0	0.0
5	0.0	6.0	16.0	16.0	15.0	10.0	0.0	0.0	0.0	0.0
6	0.0	8.0	16.0	12.0	15.0	16.0	7.0	0.0	0.0	1
7	0.0	8.0	13.0	15.0	16.0	16.0	8.0	0.0	0.0	0.0
8	0.0	7.0	12.0	14.0	16.0	8.0	0.0	0.0	0.0	0.0

## Notebook: 02a

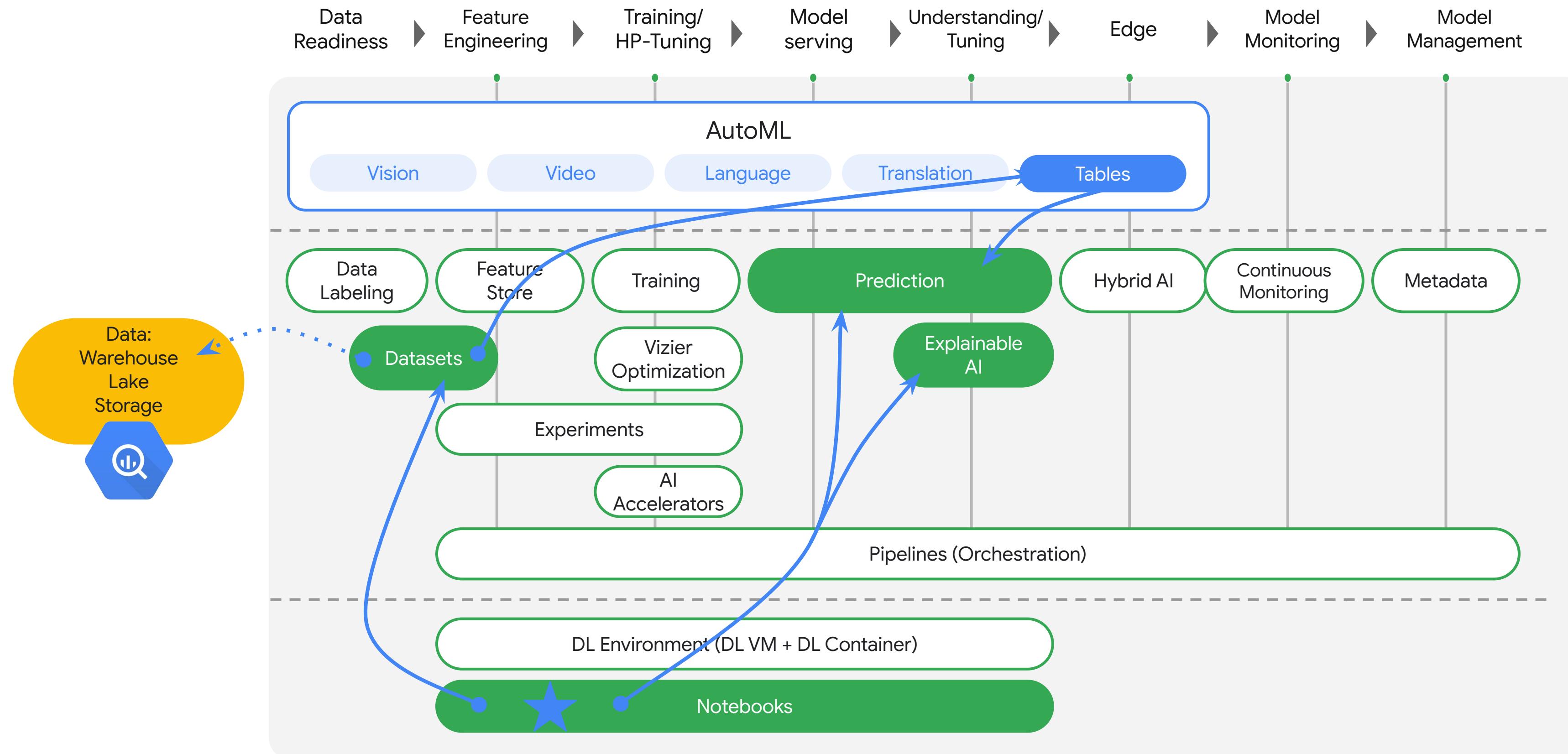
# Vertex AI Overview

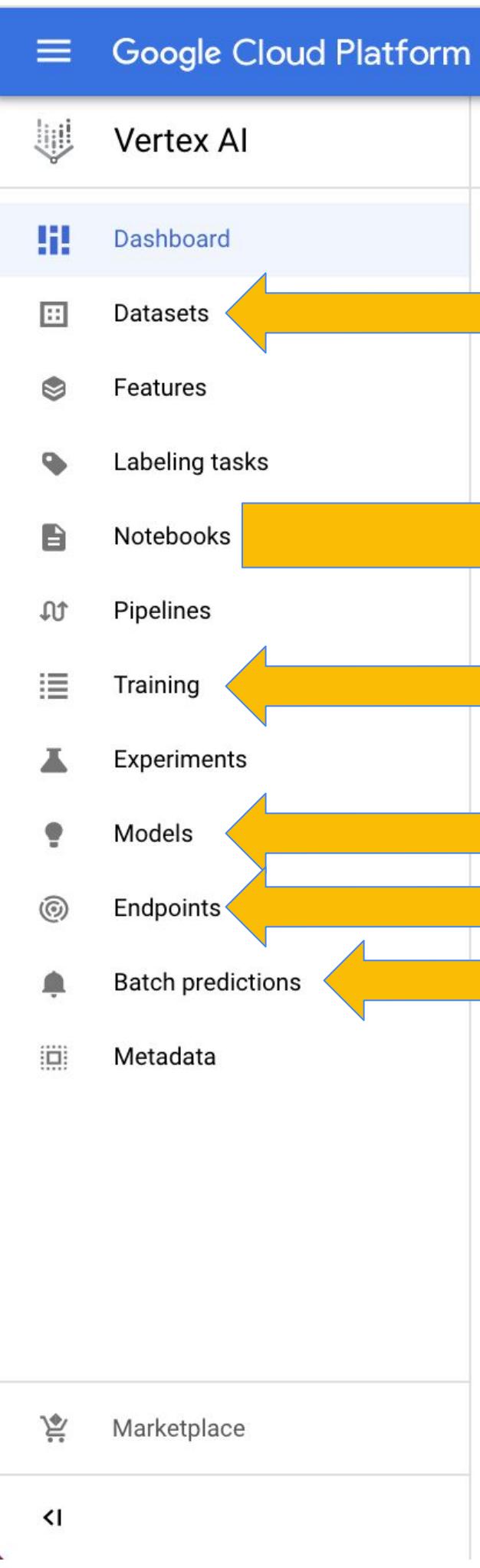




The screenshot shows the Google Cloud Platform Explorer interface. At the top, there are tabs for FEATURES & INFO, SHORTCUT, and DISABLE EDITOR TABS. Below the tabs, the 'Explorer' section displays pinned projects under the heading 'Viewing pinned projects.' One project, 'statmike-mlops', is expanded to show its contents. Under 'statmike-mlops', the 'digits' dataset is selected, indicated by a blue highlight. The 'DIGITS' tab is active in the editor area, which contains a preview of the 'digits' table. The table has columns labeled p0 through p8 and includes a header row and 8 data rows. The preview tab is currently selected.

Row	p0	p1	p2	p3	p4	p5	p6	p7	p8	p
1	0.0	5.0	16.0	15.0	5.0	0.0	0.0	0.0	0.0	
2	0.0	5.0	16.0	12.0	1.0	0.0	0.0	0.0	0.0	
3	0.0	5.0	15.0	16.0	6.0	0.0	0.0	0.0	0.0	1
4	0.0	4.0	15.0	15.0	8.0	0.0	0.0	0.0	0.0	
5	0.0	6.0	16.0	16.0	16.0	15.0	10.0	0.0	0.0	
6	0.0	8.0	16.0	12.0	15.0	16.0	7.0	0.0	0.0	1
7	0.0	8.0	13.0	15.0	16.0	16.0	8.0	0.0	0.0	
8	0.0	7.0	12.0	14.0	16.0	8.0	0.0	0.0	0.0	





**File Edit View Run Kernel Git Tabs Settings Help**

**Launcher** **02b - Vertex AI - AutoML v**

**Python 3**

## 02b - Vertex AI - AutoML with clients (code)

Use the Vertex AI Python Client to recreate the no-code approach of (02a) with code (Python). This builds a custom model with AutoML and deploys it to an Endpoint for predictions and explanations.

**Prerequisites:**

- 01 - BigQuery - Table Data Source

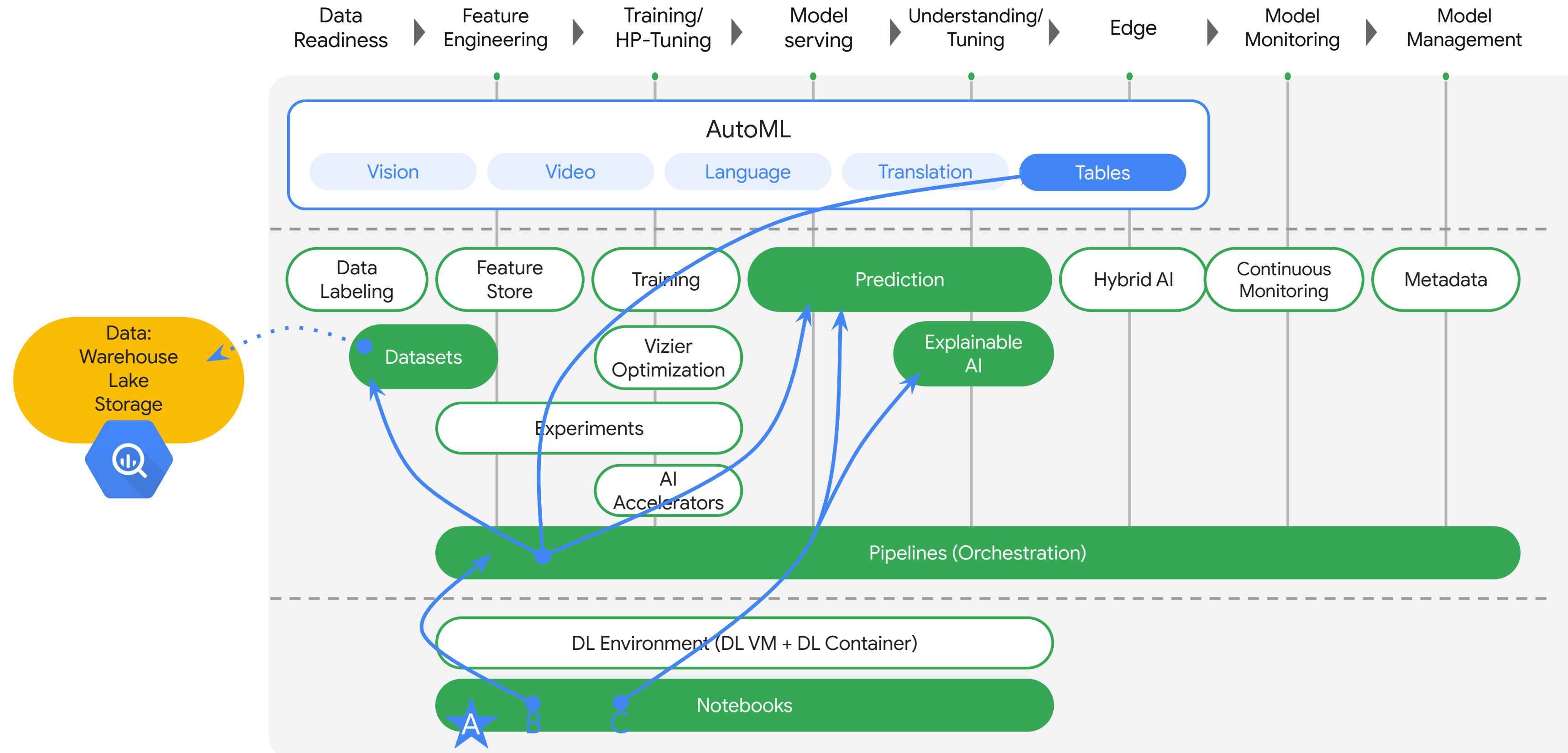
**Overview:**

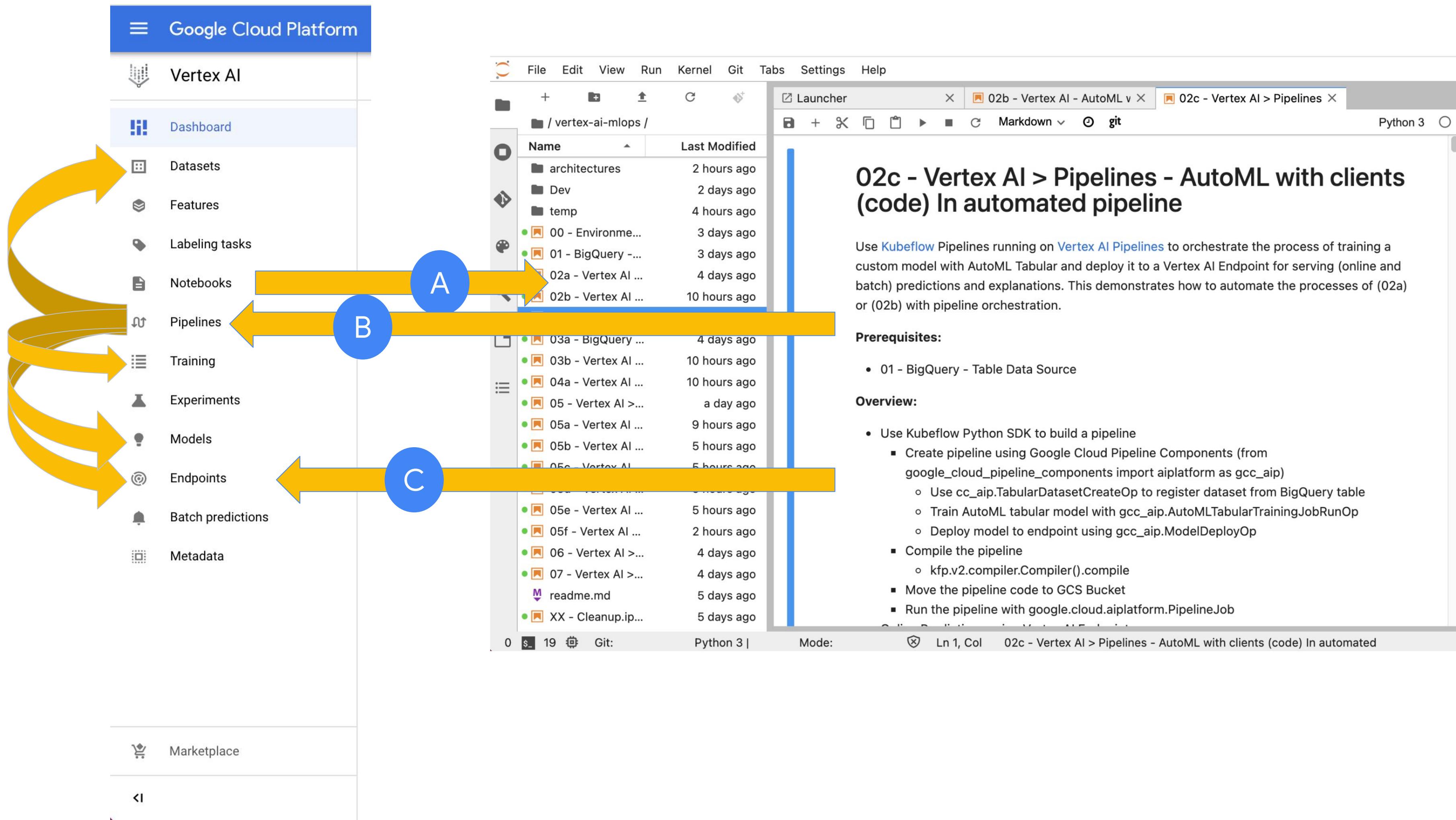
- Use Python client `google.cloud.aiplatform` for Vertex AI
  - Create a dataset
    - `aiplatform.TabularDataset`
    - Link BigQuery table
  - Train Model with AutoML
    - `aiplatform.AutoMLTabularTrainingJob`
  - Evaluate
    - Review the model in GCP Console > Vertex AI > Models
  - Deploy to Endpoint
    - `Endpoint = aiplatform.Endpoint`
    - `Endpoint.deploy`
  - Online Predictions
    - `Endpoint.predict`

Mode: Command **Ln 1, Col 1** 02b - Vertex AI - AutoML with clients (code).ipynb

Name	Last Modified
architectures	2 hours ago
Dev	2 days ago
temp	4 hours ago
01 - BigQuery - ...	3 days ago
02a - Vertex AI ...	4 days ago
<b>02b - Vertex AI ...</b>	<b>9 hours ago</b>
02c - Vertex AI ...	9 hours ago
03a - BigQuery ...	4 days ago
03b - Vertex AI ...	9 hours ago
04a - Vertex AI ...	9 hours ago
05 - Vertex AI >...	a day ago
05a - Vertex AI ...	9 hours ago
05c - Vertex AI ...	5 hours ago
05d - Vertex AI ...	5 hours ago
05e - Vertex AI ...	4 hours ago
06 - Vertex AI >...	2 hours ago
readme.md	4 days ago
requirements.ip...	4 days ago
M README	5 days ago
run.ip...	5 days ago

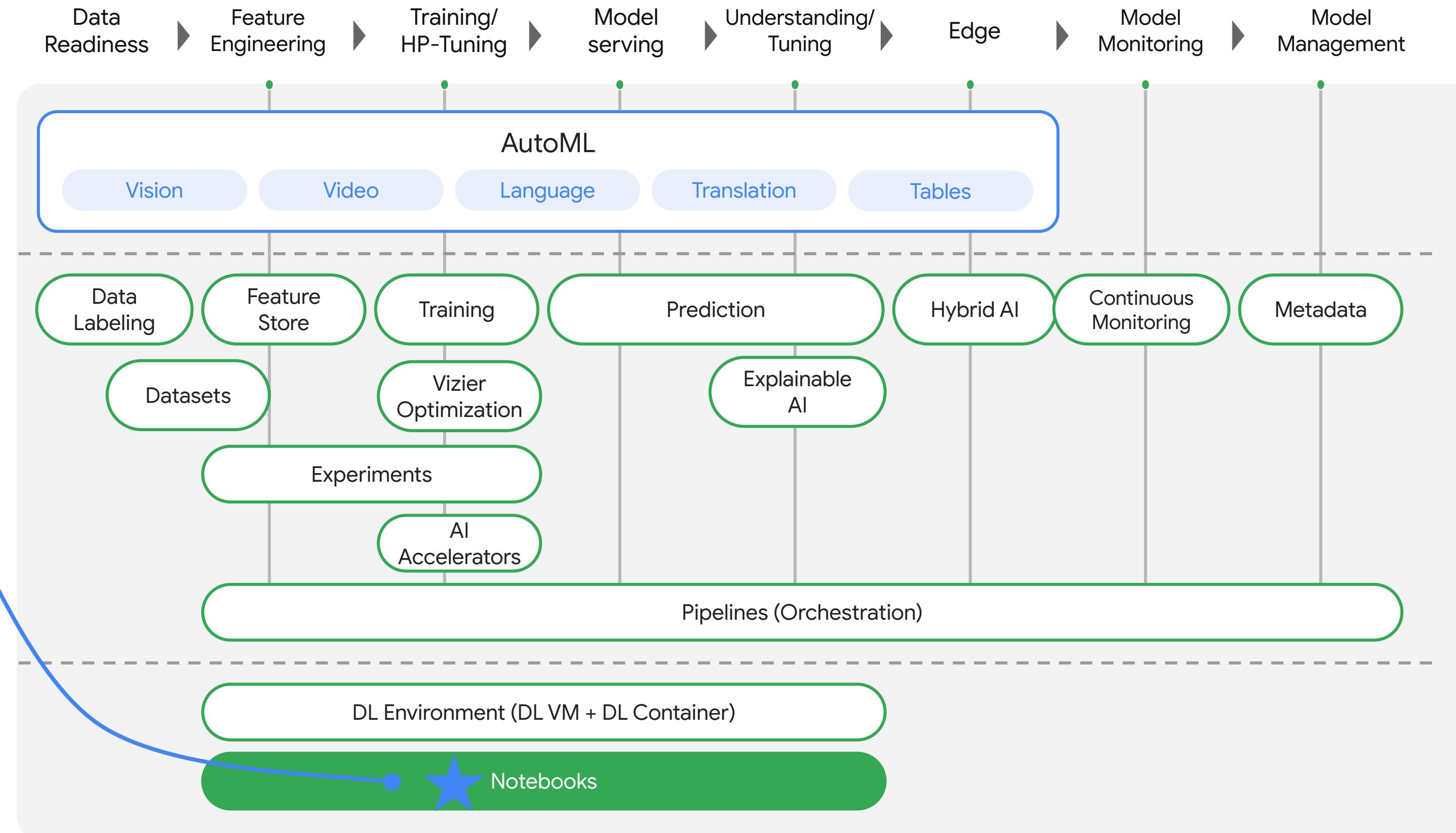
0 \$ 19 Git: idle Python 3 | Idle





## Notebook: 03a

# Vertex AI Overview



Google Cloud Platform

Vertex AI

- Dashboard
- Datasets
- Features
- Labeling tasks
- Notebooks
- Pipelines
- Training
- Experiments
- Models
- Endpoints
- Batch predictions
- Metadata

Marketplace

Google Cloud Platform statmike-mlops Search products and resources

FEATURES & INFO SHORTCUT DISABLE EDITOR TABS

Explorer + ADD DATA EDITOR DIGITS DIGITS\_LR

Type to search

Viewing pinned projects.

statmike-mlops digits Models (1) digits\_lr digits digits\_featurestore\_import digits\_fs\_training digits\_preped

DETAILS TRAINING EVALUATION SCHEMA

Loss Duration (sec)

10 Training loss: 0.011 Evaluation loss: 0.014

Duration (seconds)

File Edit View Run Kernel Git Tabs Settings Help

/ vertex-ai-mlops /

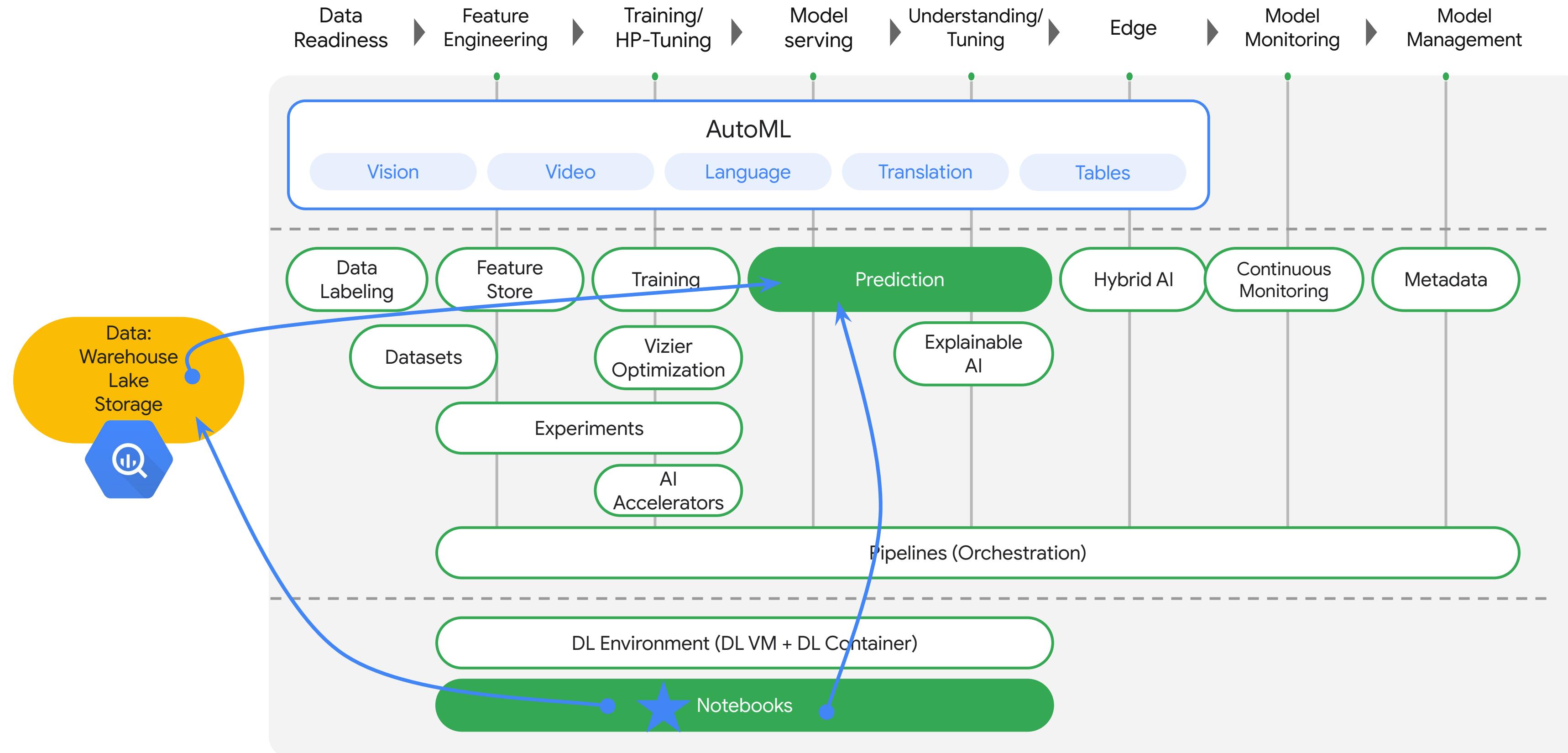
Name	Last Modified
architectures	3 hours ago
Dev	2 days ago
temp	5 hours ago
00 - Environment...	3 days ago
01 - BigQuery -...	3 days ago
02a - Vertex AI ...	4 days ago
02b - Vertex AI ...	10 hours ago
02c - Vertex AI ...	10 hours ago
03a - BigQuery Machine Learning (BQML) - Machine Learning with SQL	4 days ago

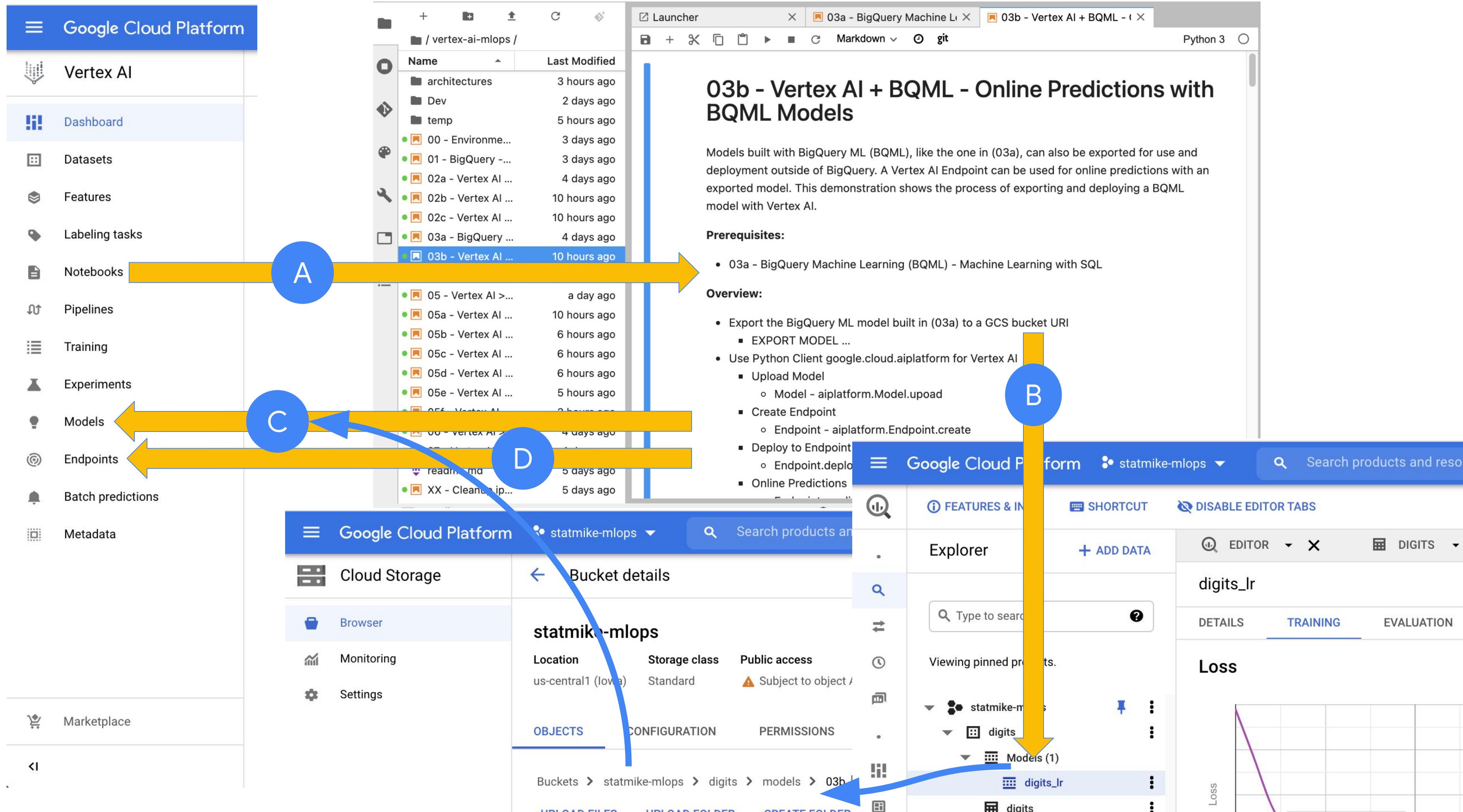
03a - BigQuery Machine Learning (BQML) - Machine Learning with SQL

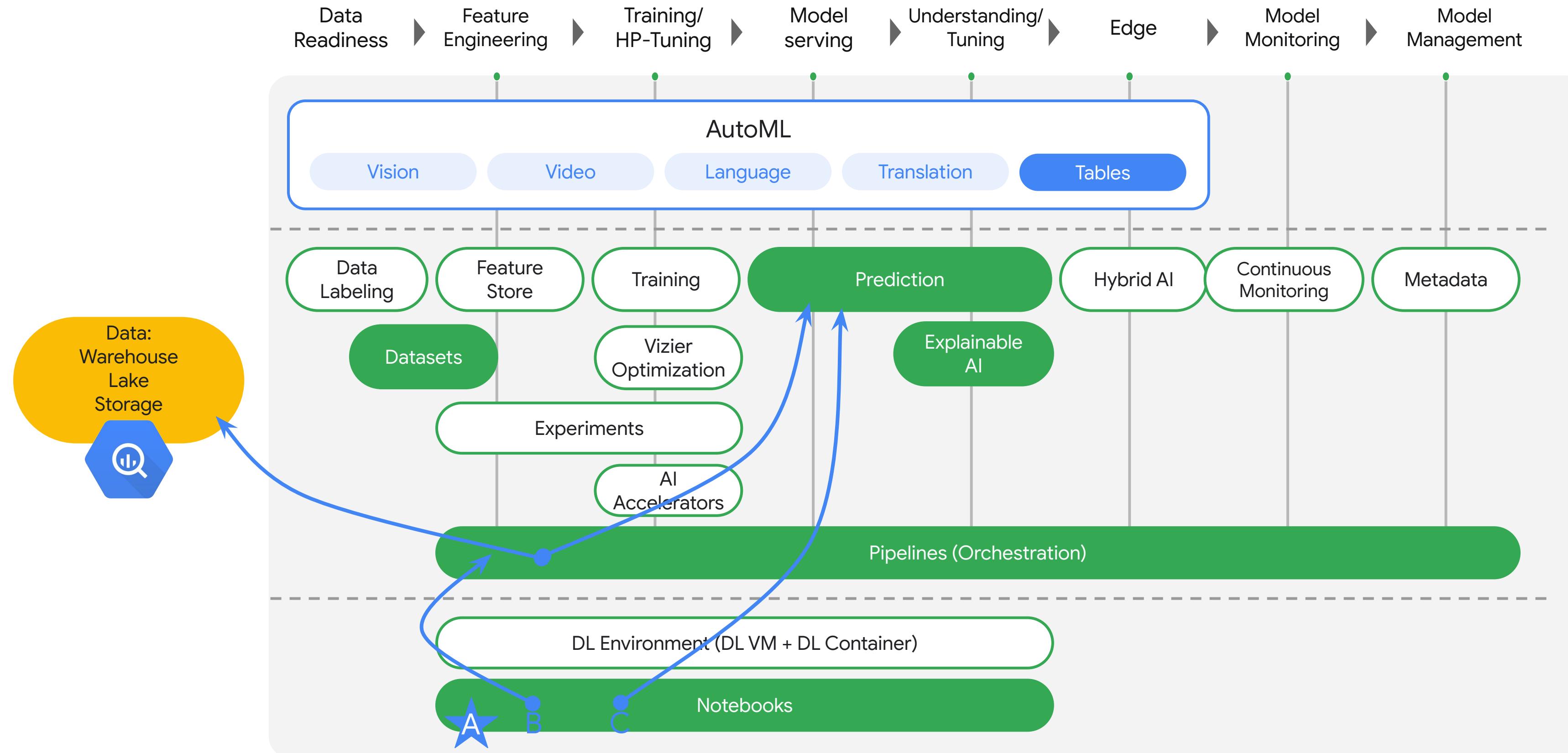
BigQuery has a number of machine learning algorithms callable directly from SQL. This gives the convenience of using the common language of SQL to "CREATE MODEL ..."). The library of available models is constantly growing and covers supervised, unsupervised, and time series methods as well as functions for evaluation - even anomaly detection from results, explainability and hyperparameter tuning. A great starting point for seeing the scope of available methods is [your journey for models](#).

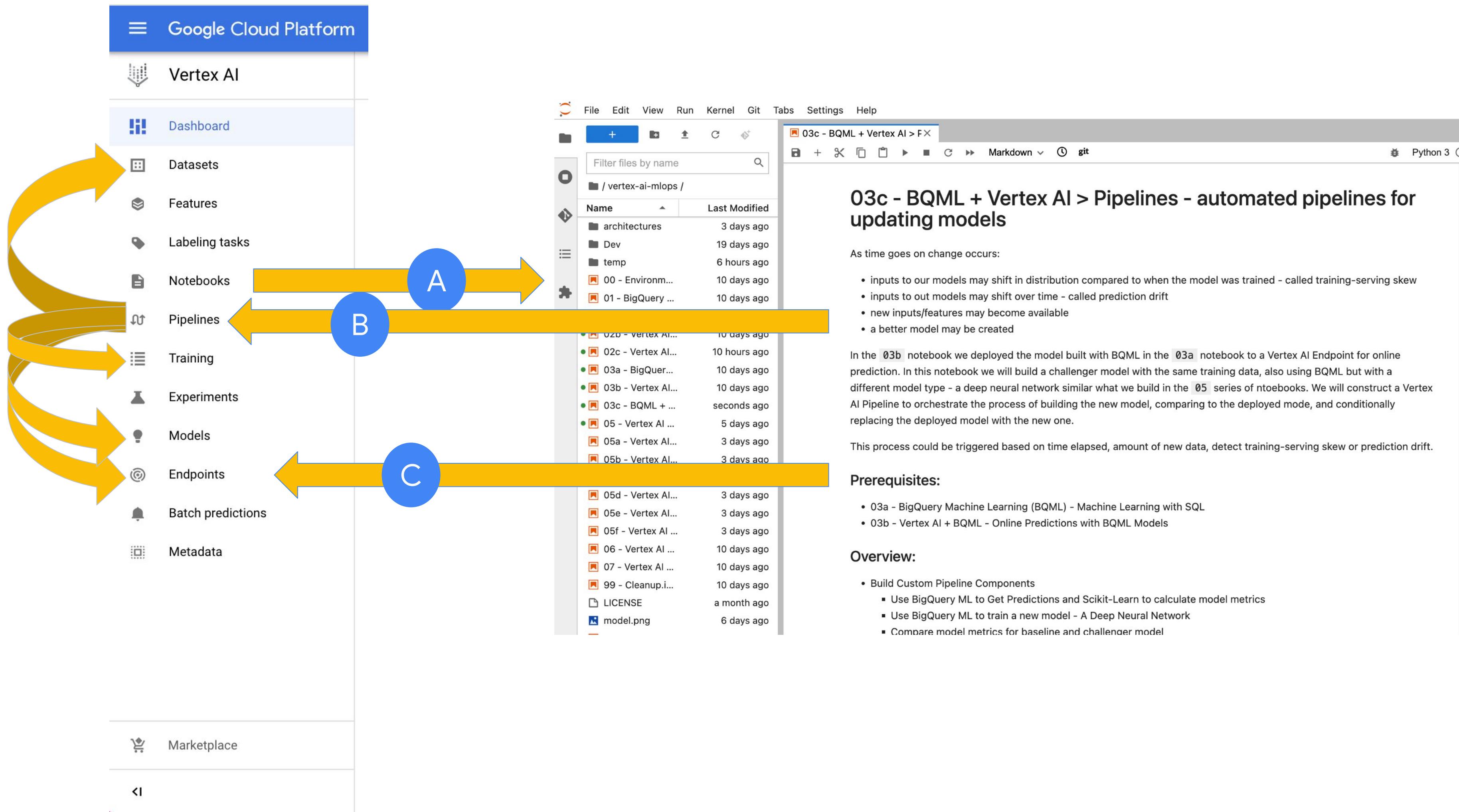
## Notebook: 03b

# Vertex AI Overview



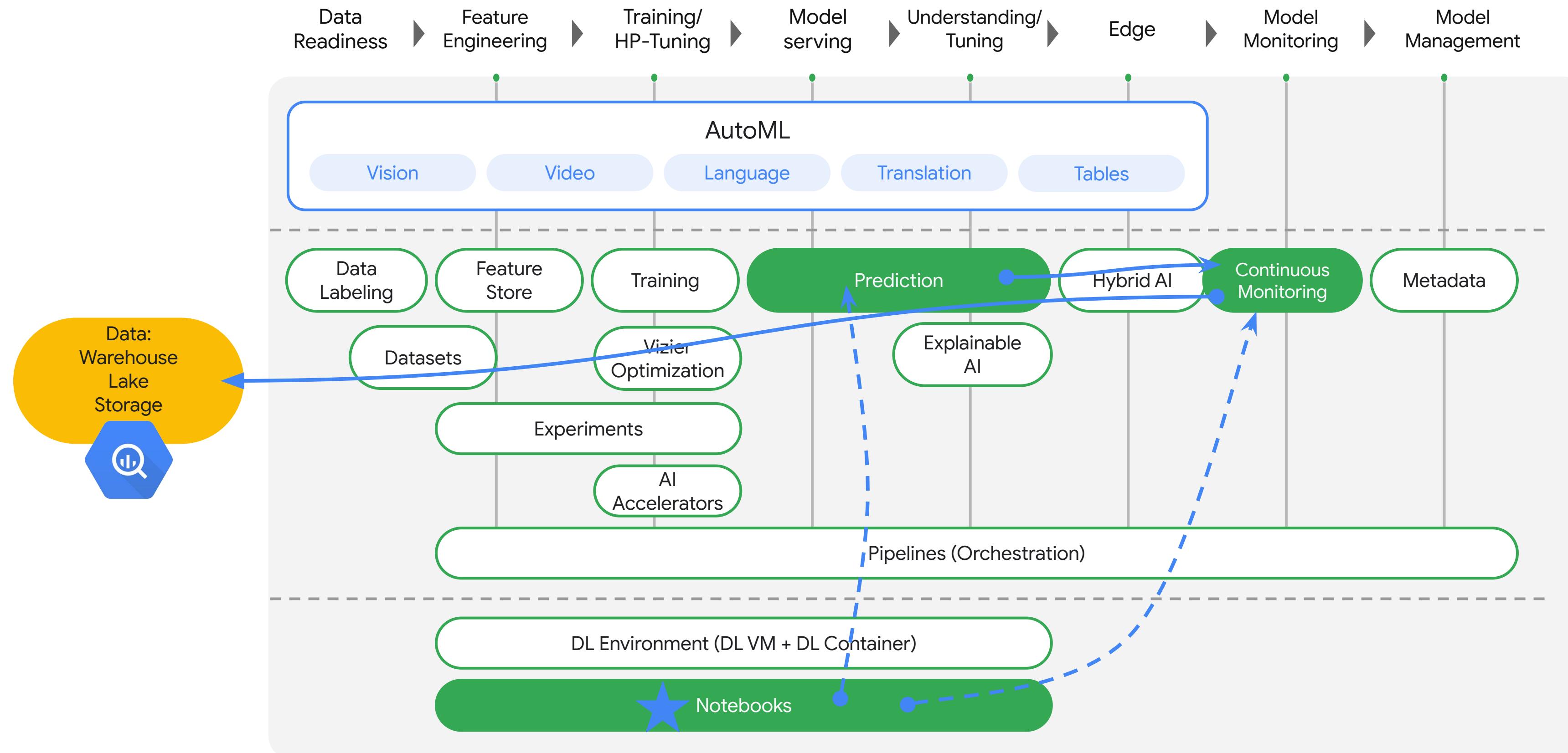






## Notebook: 04a

# Vertex AI Overview



Dashboard

Datasets

Features

Labeling tasks

Notebooks

Pipelines

Training

Experiments

Models

Endpoints

Batch predictions

Metadata

Marketplace

**A**

**B**

**04a - Vertex AI > Model Monitoring**

In other notebooks the end-to-end workflows include serving trained ML models on Vertex AI endpoints. In this notebook, an endpoint will be extended by enabling model monitoring. This enables continuous scheduled monitoring of selected model features for deviations:

- Training-serving skew: feature distribution is different from the feature distribution in the training data
- Prediction drift: feature distribution is different over time

The monitor

Feature: Amount

Feature distribution

Snapshot of distributions when job ran at Feb 25, 2022, 2:00:00 AM

Anomaly detected during this job run. Distribution deviation value: 0.45. Anomaly detection threshold: 0.001.

Prerequisites

- 02a - Vertex AI > Model Monitoring
- or
- Pipelines

Overview

- Find Existing Endpoints
- Predictions
- Start Monitoring
- Set up monitoring
- Set up alerts

Model features

Monitoring job runs every 1 hour

Monitoring jobs (up to last 50)

Feb 25, 2022, 2:00:00 AM

Feb 25, 2022, 1:00:00 AM

Feb 25, 2022, 12:00:00 PM

Feb 24, 2022, 10:00:00 PM

Feb 24, 2022, 9:00:00 PM

Feb 24, 2022, 8:00:00 PM

Feb 24, 2022, 7:00:00 PM

Feb 24, 2022, 6:00:00 PM

Feb 24, 2022, 4:00:00 PM

Feb 24, 2022, 3:00:00 PM

Training stats distribution

Feature

Amount

V25

V26

V27

V28

Amount

V25

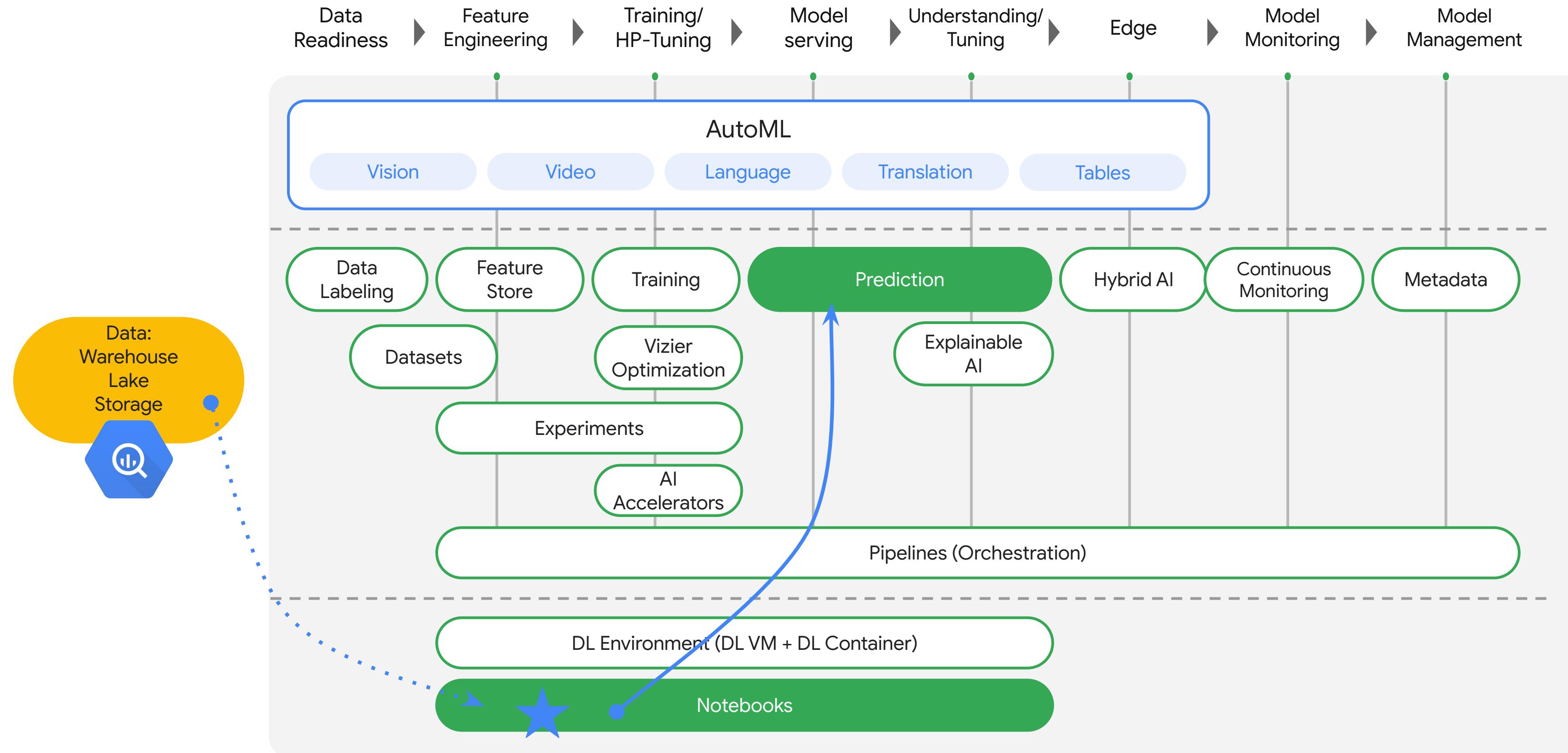
V26

V27

V28

## Notebook: 05

# Vertex AI Overview



**A**

**B**

**C**

**D**

## 05 - Vertex AI > Notebooks - Models Built in Notebooks with Tensorflow

Where a model gets trained is where it consumes computing resources. With Vertex AI, you have choices for configuring the computing resources available at training. This notebook is an example of an execution environment. When it was set up there were choices for machine type and accelerators (GPUs).

This notebook shows training a model directly within the runtime of the notebook environment. Then the model is saved and moved to GCS for deployment to a Vertex AI Endpoint for online predictions. The model training is done with [Tensorflow](#), [Keras](#), and was designed to show a neural network approach to logistic regression. Training data batches are read from BigQuery using [Tensorflow I/O](#).

**Prerequisites:**

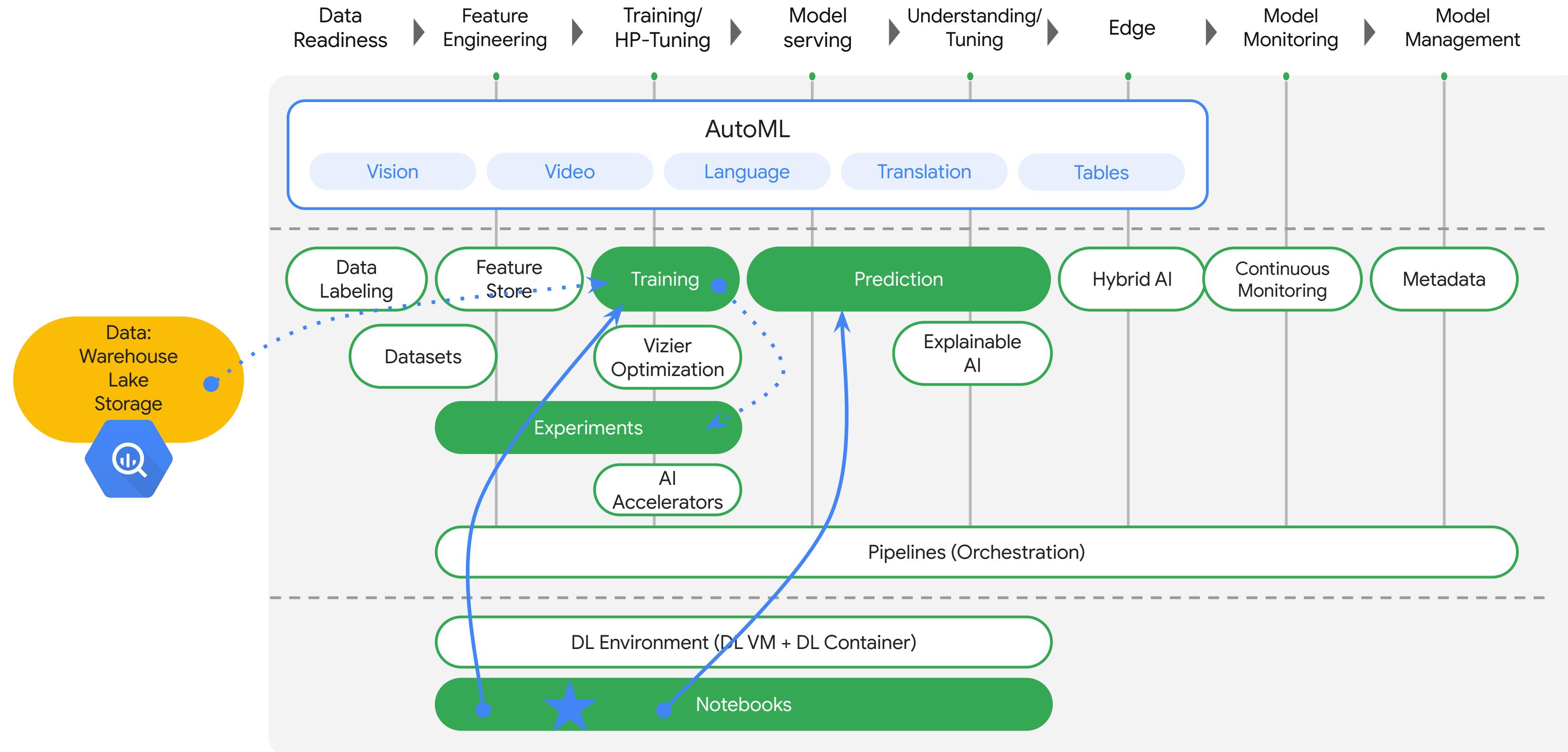
- 01 - BigQuery - Table Data Source

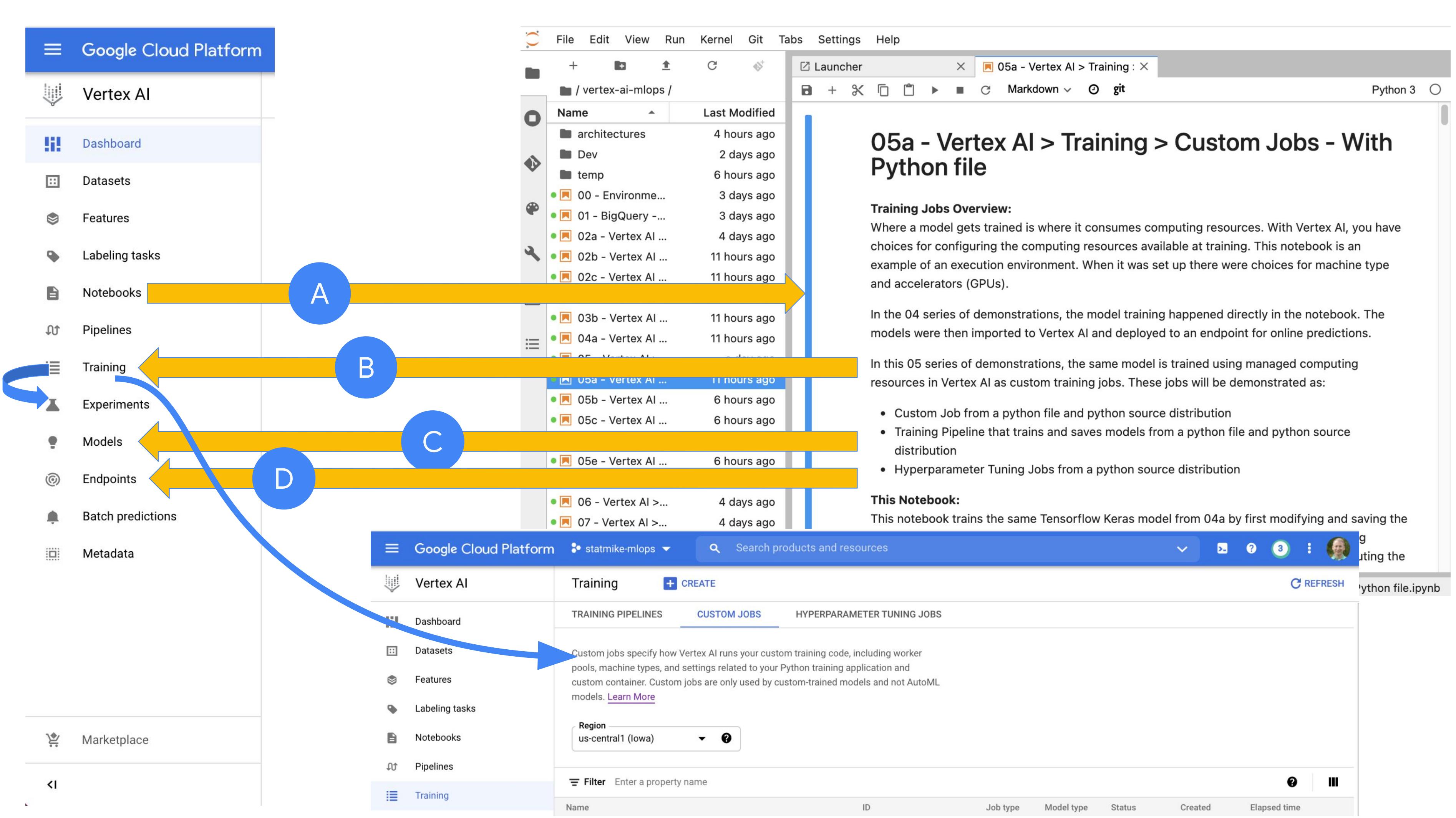
**Overview:**

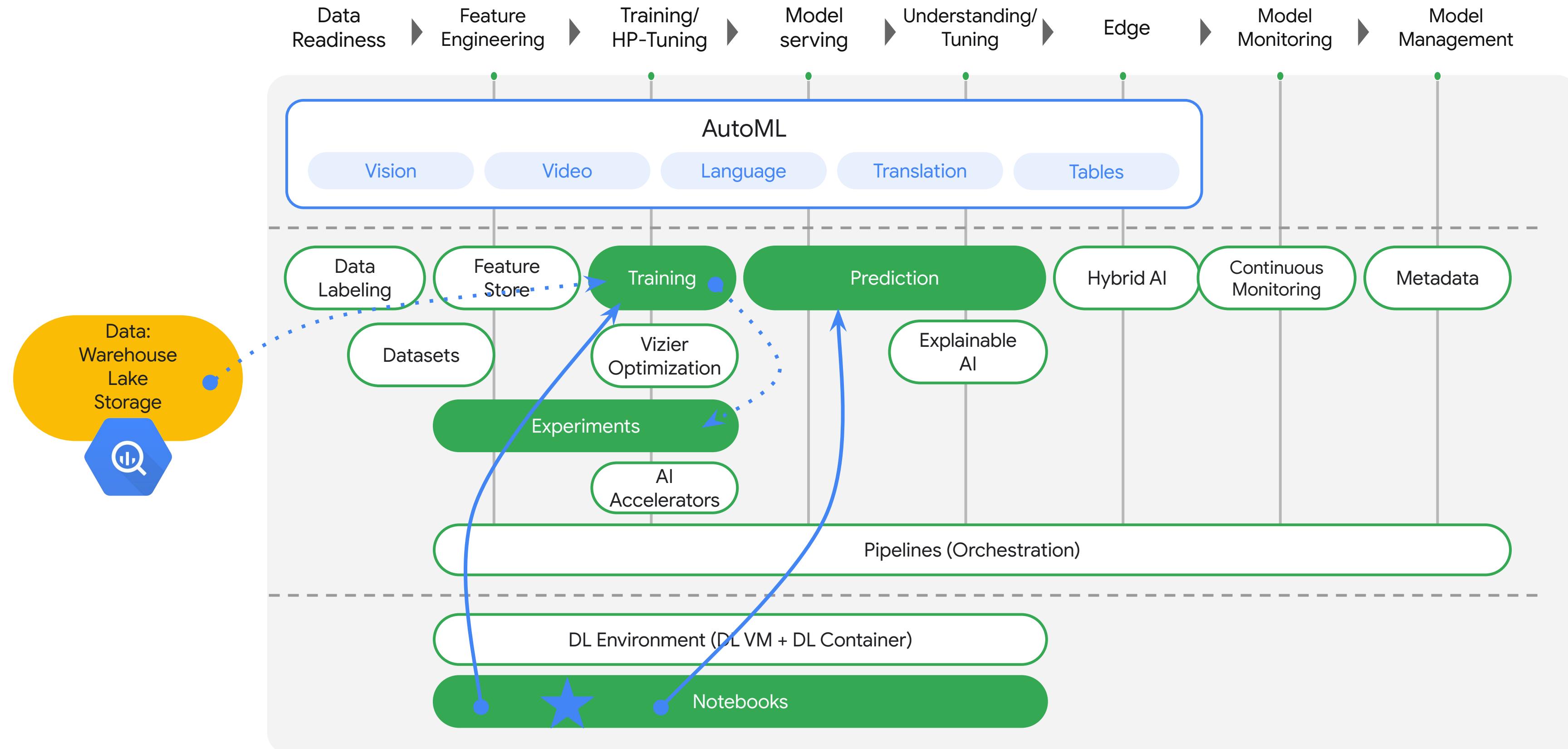
- Use Python Client for BigQuery
  - Read the tables schema from BigQuery INFORMATION\_SCHEMA
  - Prepare the feature information for Tensorflow
- Define a function that remaps the input data into features and target variables where target is one-hot encoded (classification model with 10 classes)
- Set Tensorflow I/O read session
- Demonstrate reading a single batch
- Train a Tensorflow model
  - Define the model layers

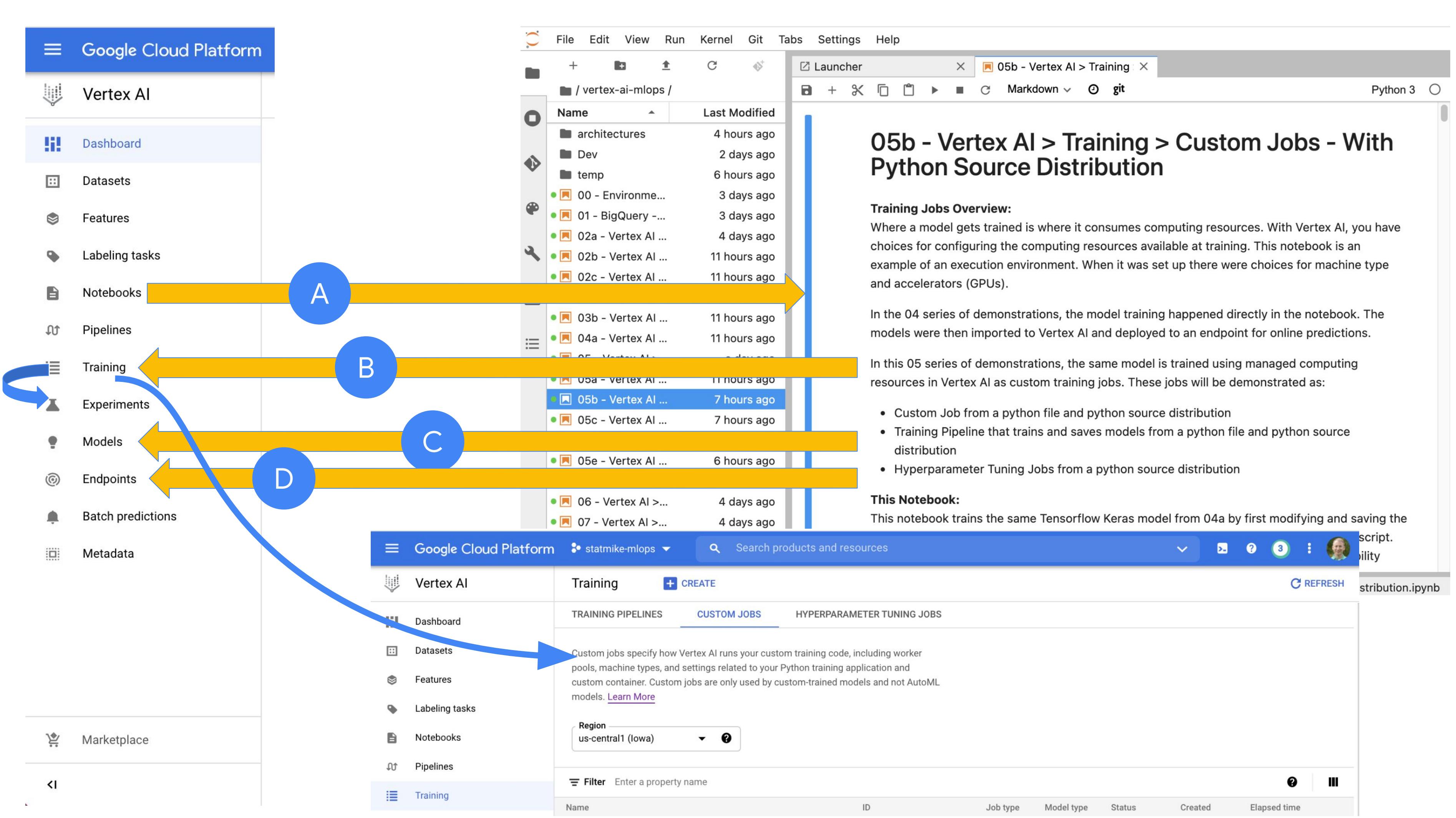
## Notebook: 05a

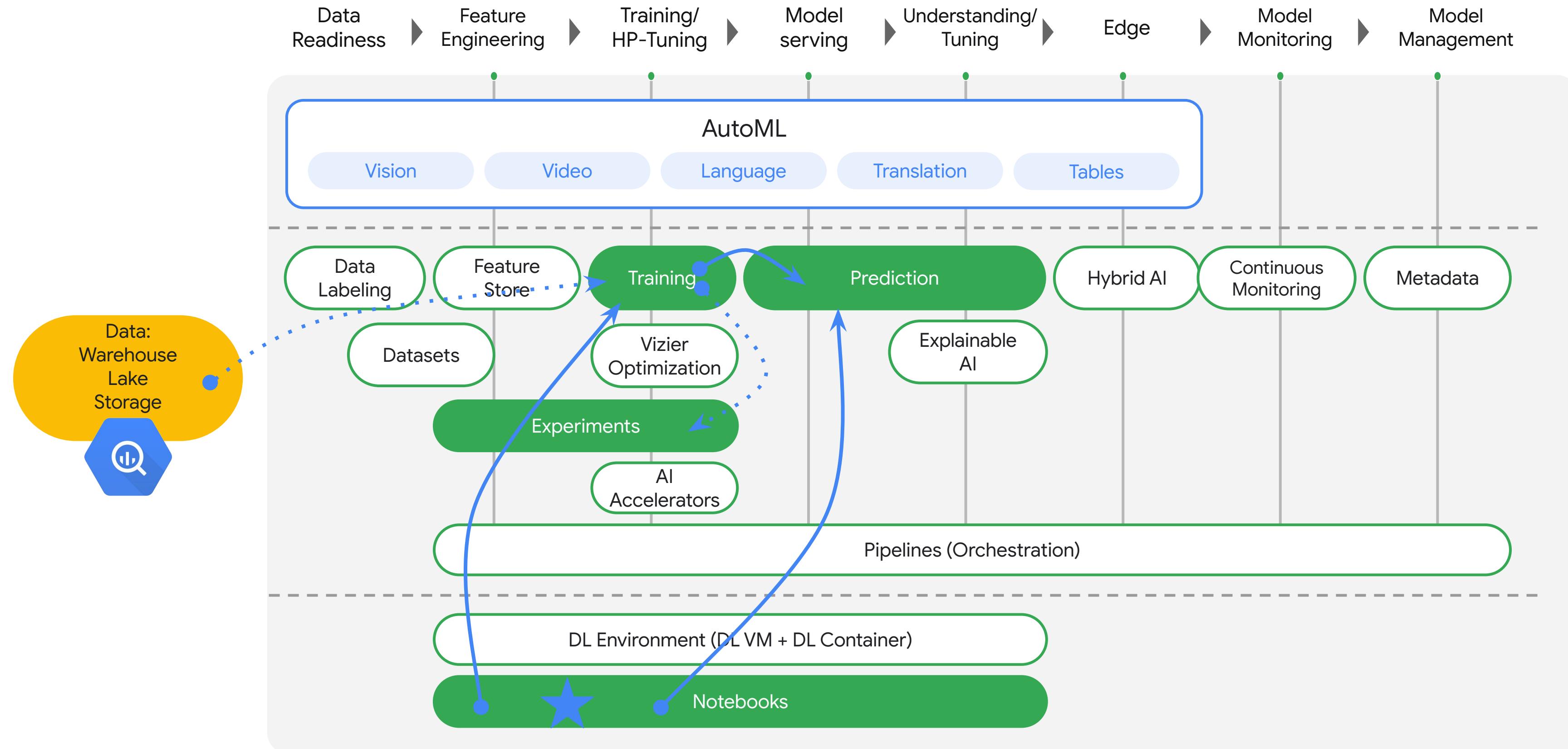
# Vertex AI Overview

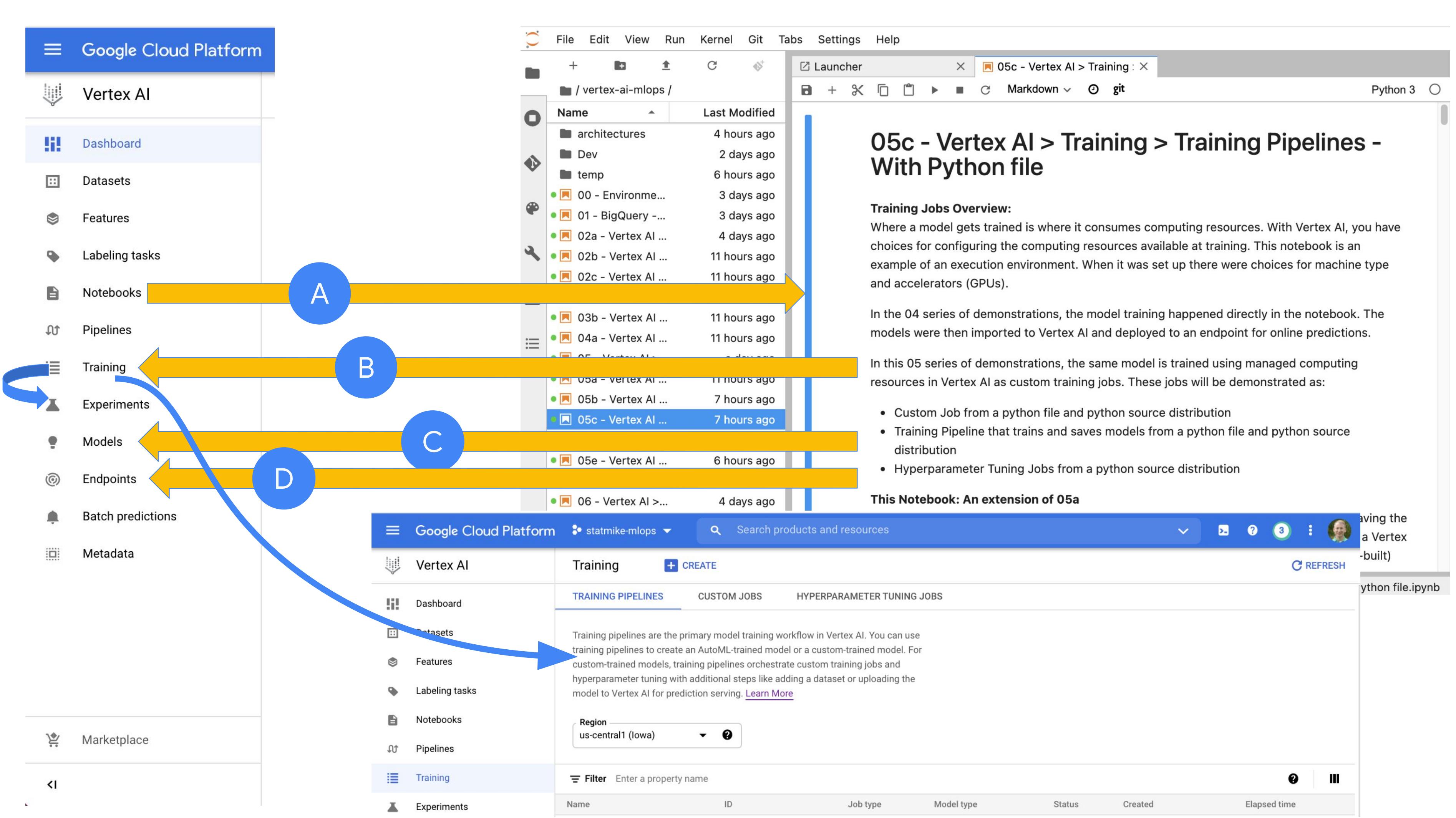


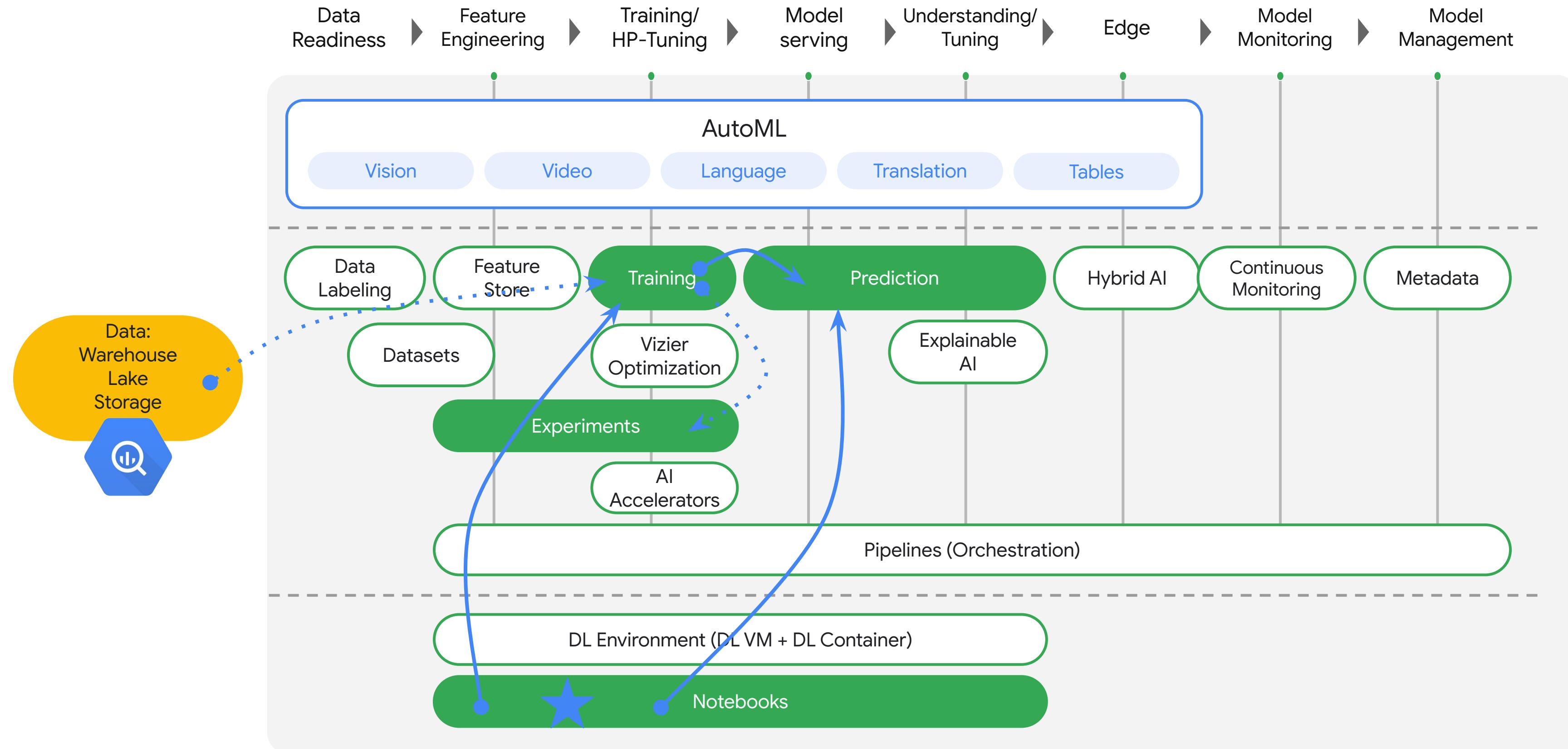


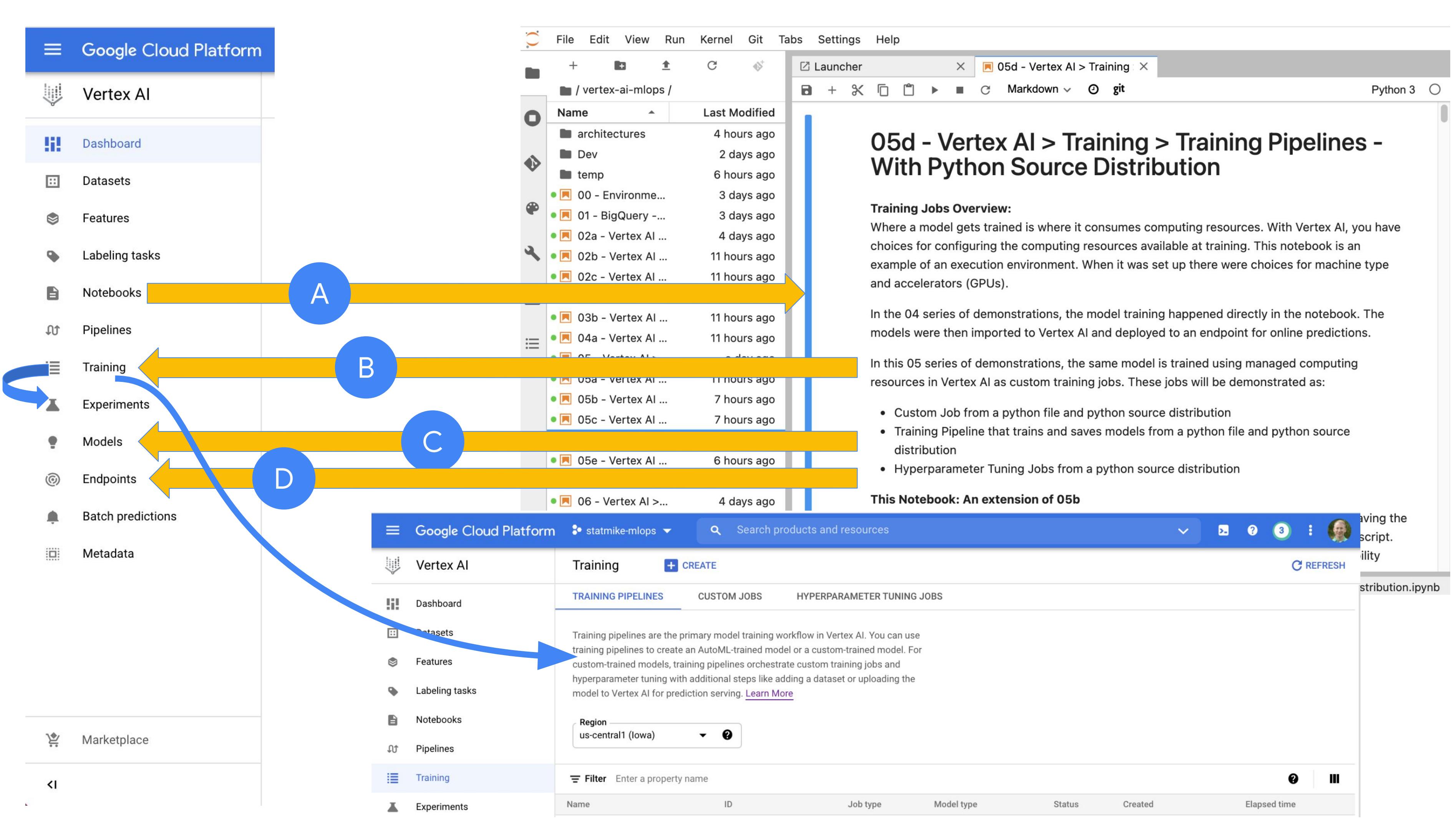


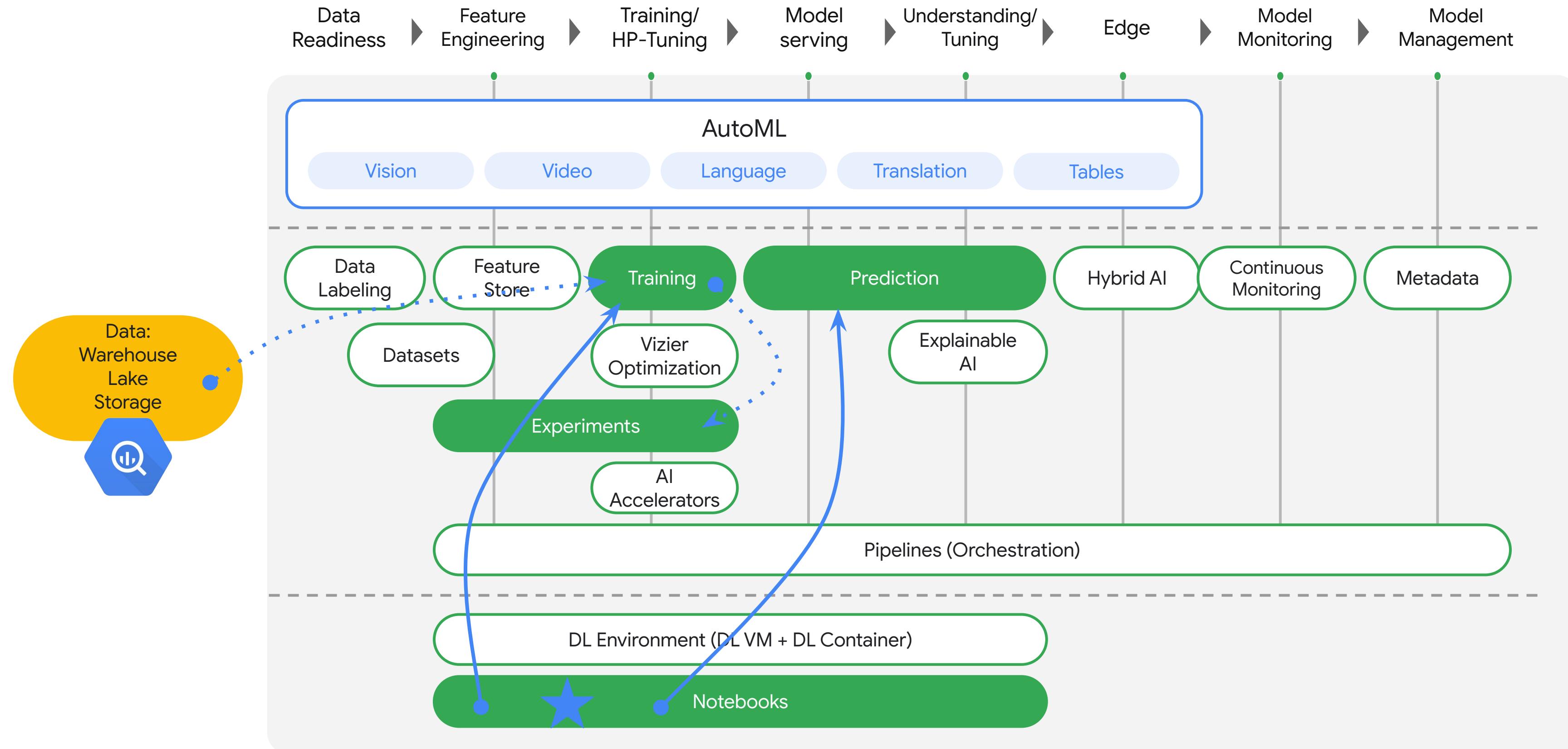


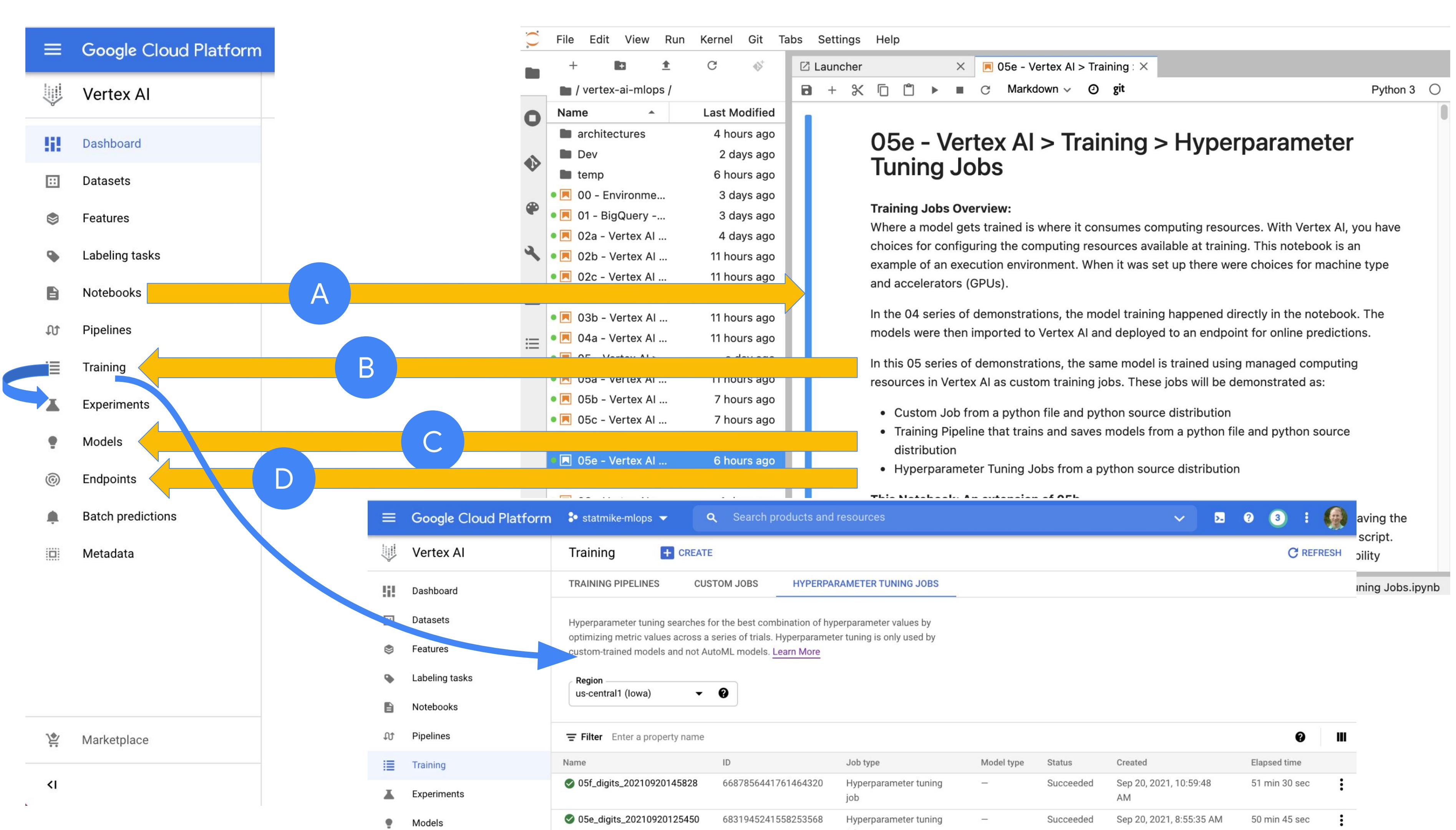






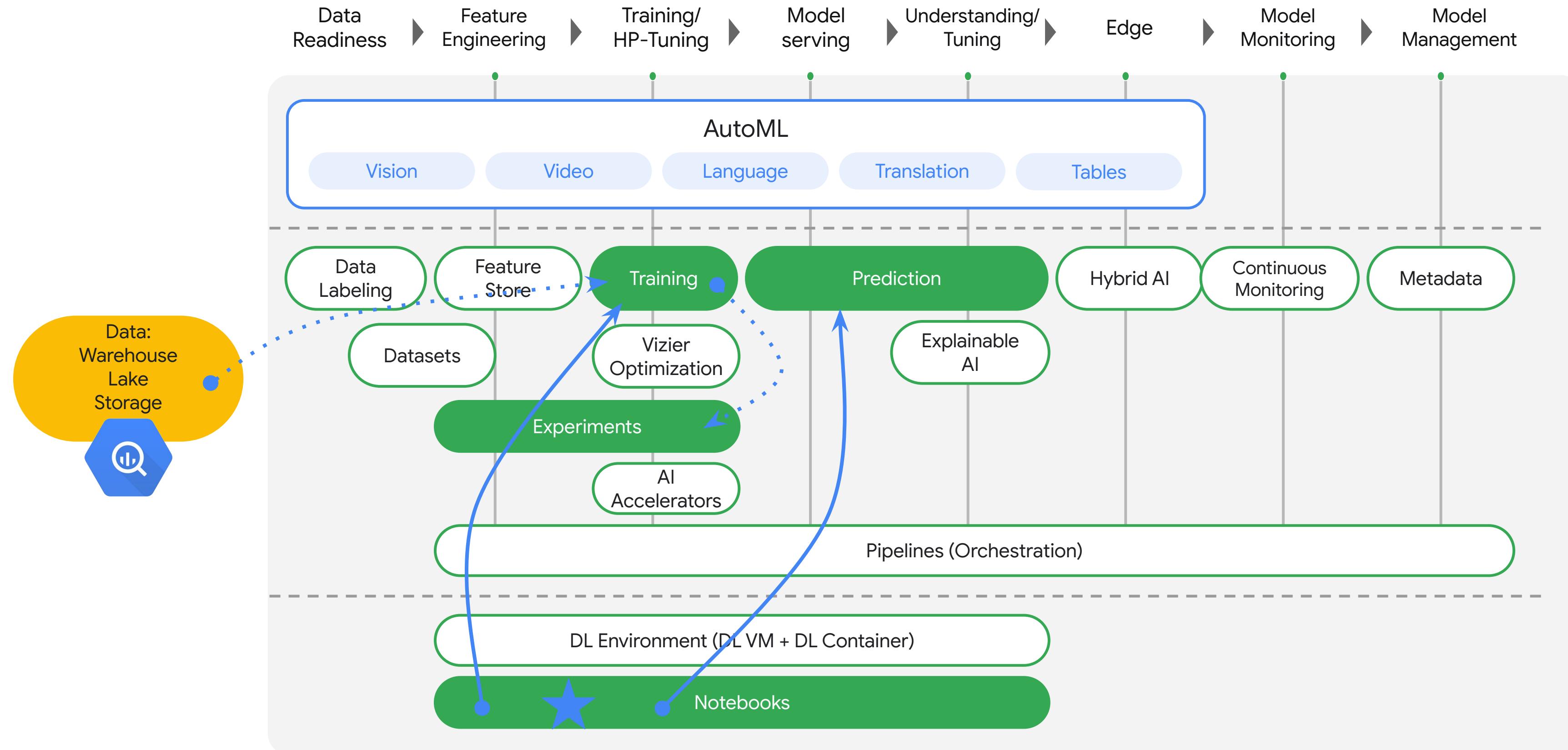


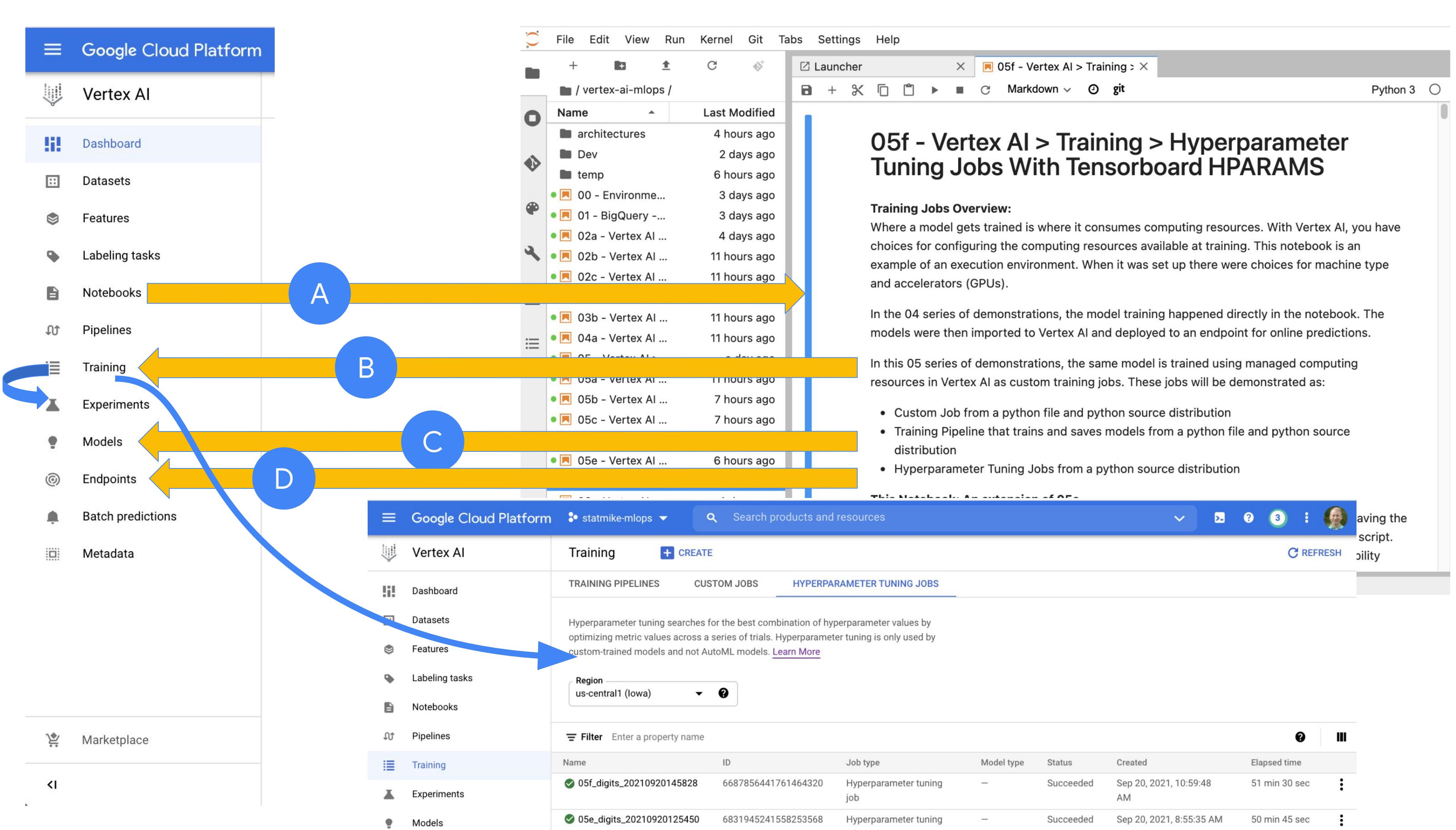




## Notebook: 05f

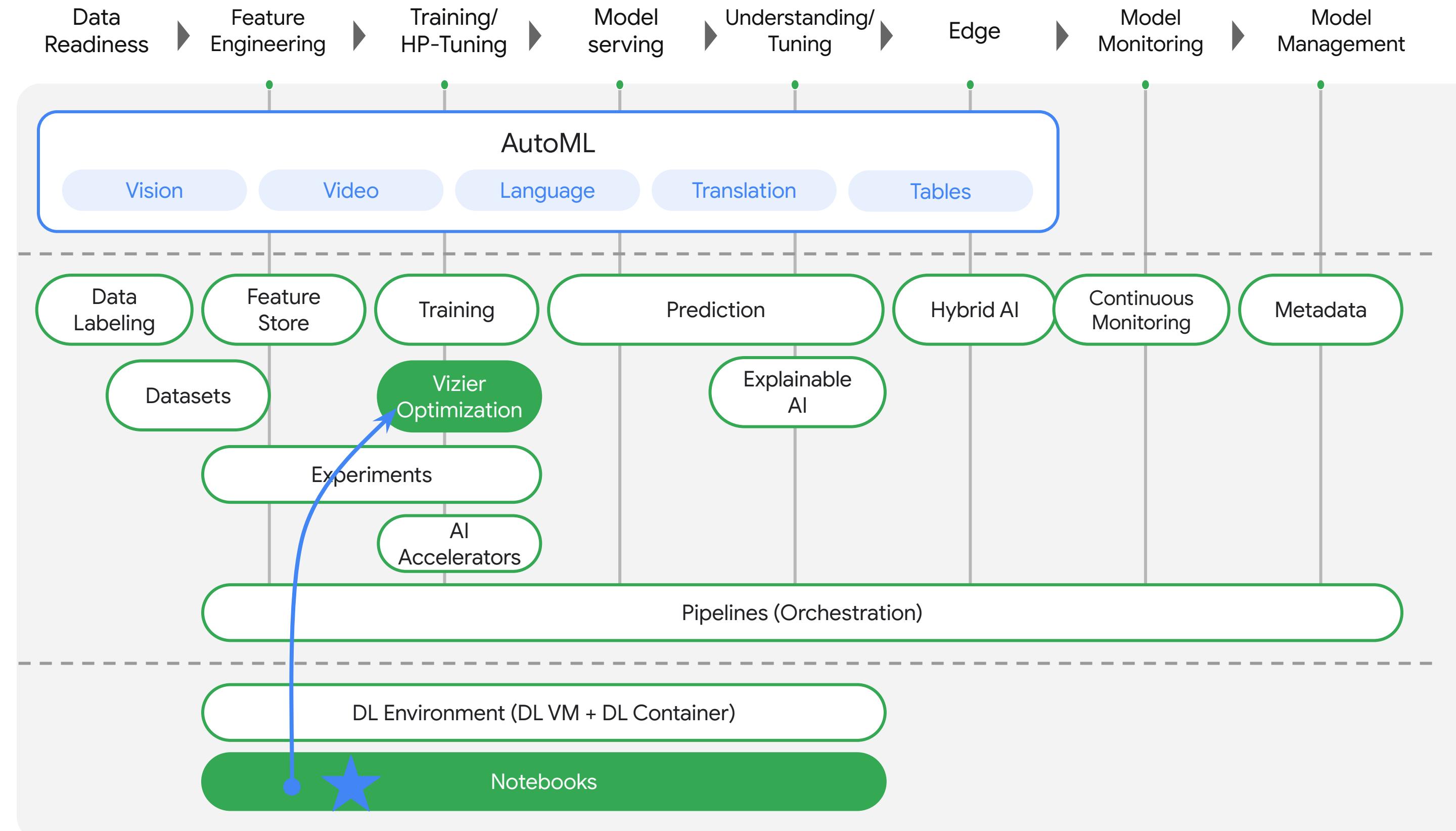
# Vertex AI Overview





## Notebook: 06

# Vertex AI Overview



The diagram illustrates the workflow for setting up and managing experiments using Vertex AI Vizier. It starts with the Google Cloud Platform Vertex AI dashboard, where the 'Notebooks' section is highlighted (A). A blue arrow points from the dashboard to a Jupyter Notebook interface titled '06 - Vertex AI > Experim...'. The notebook shows a file tree for 'vertex-ai-mlops/' containing various Jupyter notebooks related to Vertex AI and Vizier. A second blue arrow points from the Jupyter interface to the 'Studies' page in the Google Cloud Platform Vertex AI dashboard (B). The 'Studies' tab is selected, showing two studies: 'Study\_06\_Bayesian\_Optimization' and 'Study\_06\_Random'. Both studies have the same objective: 'Minimize "blue" and Maximize "green"'. The 'Created' column indicates they were both created on Sep 16, 2021.

Google Cloud Platform

Vertex AI

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Marketplace

A

B

File Edit View Run Kernel Git Tabs Settings Help

/ vertex-ai-mlops /

Name Last Modified

- architectures 4 hours ago
- Dev 2 days ago
- temp 6 hours ago
- 00 - Environme... 3 days ago
- 01 - BigQuery -... 3 days ago
- 02a - Vertex AI ... 4 days ago
- 02b - Vertex AI ... 12 hours ago
- 02c - Vertex AI ... 12 hours ago
- 03b - Vertex AI ... 11 hours ago
- 04a - Vertex AI ... 11 hours ago
- 05 - Vertex AI >... a day ago
- 05a - Vertex AI ... 11 hours ago
- 05c - Vertex AI ... 7 hours ago
- 05d - Vertex AI ... 7 hours ago
- 05e - Vertex AI ... 7 hours ago

Launcher 06 - Vertex AI > Experim...

Markdown git

Python 3

## 06 - Vertex AI > Experiments > Studies - Vizier Optimization Service

Vertex AI Vizier is an optimization service. It is used to optimize hyperparameters for machine learning models - called hyperparameter tuning. It can also optimize any system that can be evaluated. Even systems with multiple objectives.

In this demonstration, multiple objectives are set and the Vizier service is used to conduct a random search and a default search (Bayesian Optimization) for comparison.

To see an example of hyperparameter tuning see notebook 05e or 05f. Those notebooks use the `aiplatform.HyperparameterTuningJob()` to manage the process rather than interacting with the Vertex AI Vizier service directly. Also see [this example](#).

**Prerequisites:**

- None

**Overview:**

Google Cloud Platform statmike-mlops Search products and resources REFRESH ynb

Vertex AI Studies

EXPERIMENTS PREVIEW STUDIES PREVIEW TENSORBOARD INSTANCES PREVIEW

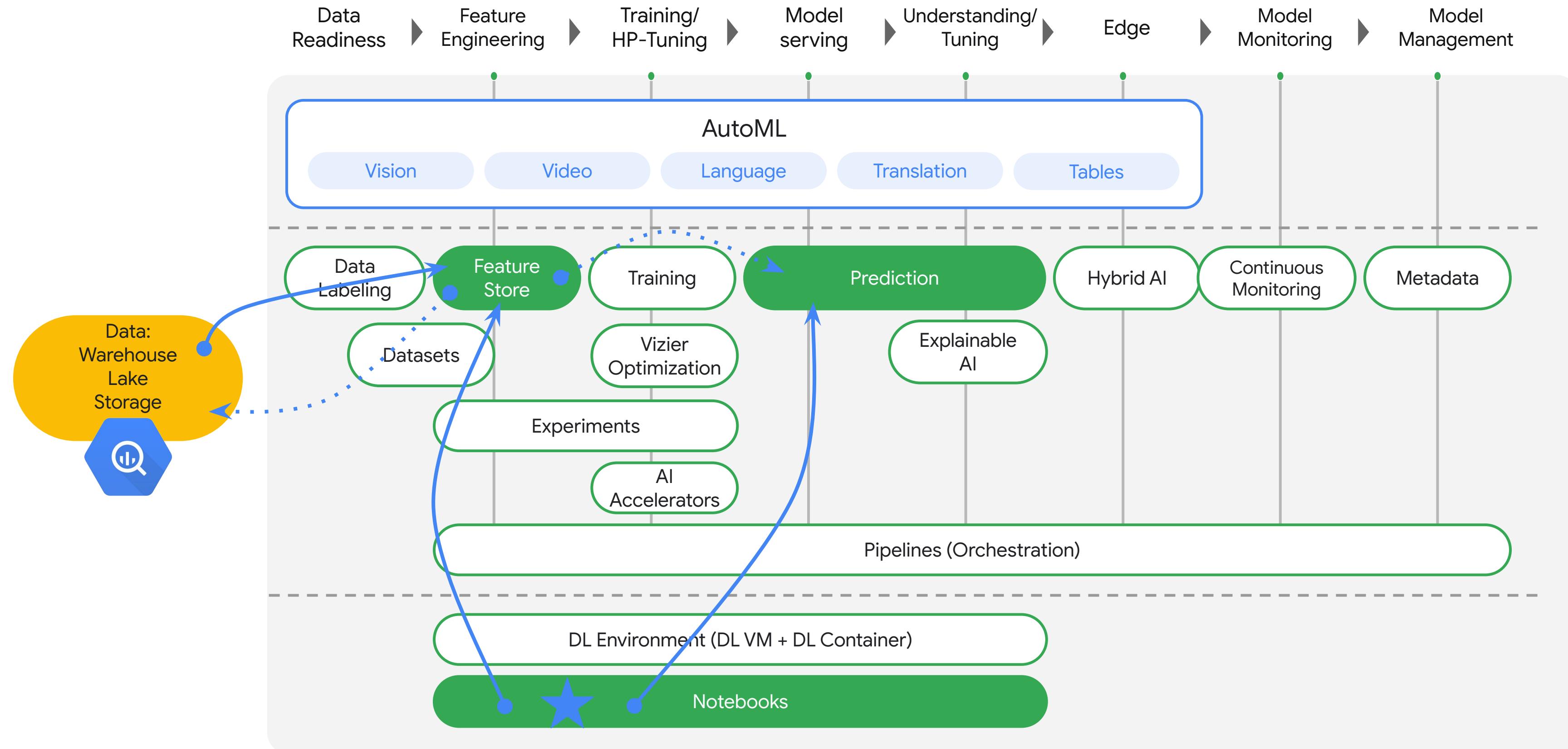
Region us-central1 (Iowa)

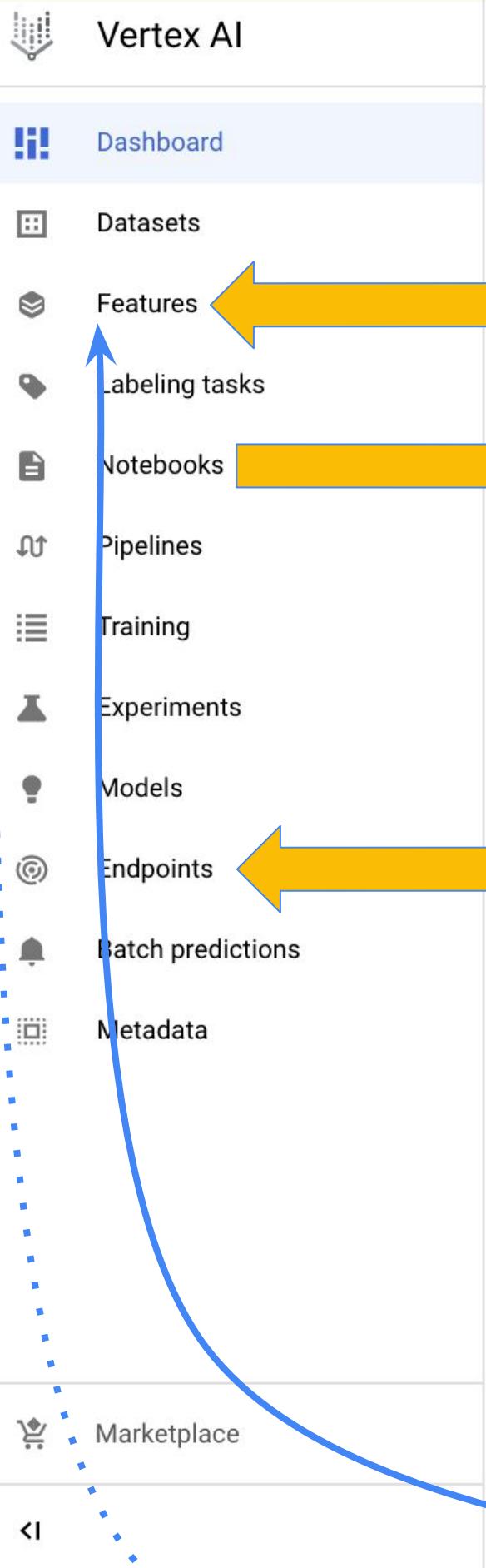
Filter Enter property name or value

Study name	ID	Objective	Created
Study_06_Bayesian_Optimization	4214226082825	Minimize "blue" and Maximize "green"	Sep 16, 2021, 11:51:29 AM
Study_06_Random	639592116037	Minimize "blue" and Maximize "green"	Sep 16, 2021, 11:44:46 AM

# Notebook: 07

# Vertex AI Overview





File Edit View Run Kernel Git Tabs Settings Help

/ vertex-ai-mlops /

Name	Last Modified
architectures	4 hours ago
Dev	2 days ago
temp	6 hours ago
01 - BigQuery ...	3 days ago
02a - Vertex AI ...	4 days ago
02b - Vertex AI	12 hours ago
02c - Vertex AI ...	12 hours ago
03a - BigQuery ...	4 days ago
03b - Vertex AI ...	11 hours ago
04a - Vertex AI ...	11 hours ago
05 - Vertex AI >...	a day ago
05a - Vertex AI ...	11 hours ago
05b - Vertex AI ...	7 hours ago
05c - Vertex AI ...	7 hours ago
05d - Vertex AI ...	7 hours ago

Launcher 07 - Vertex AI > Features - X

Markdown git Python 3

## 07 - Vertex AI > Features - Feature Store

This is a demonstration of [Vertex AI Feature Store](#). A feature store is a central repository for organizing, storing, and retrieving features. This is a fully managed service that scales the underlying compute and storage resources. The feature store becomes a central location for serving features for training and prediction with low-latency. It stores feature values at points-in-time:

- Point-in-time lookups for retrieving features for model training. Retrieve feature values prior to a prediction to prevent data leakage.
- Manage training-serving skew

**Prerequisites:**

- 01 - BigQuery - Table Data Source
- Any of 02-05 That Deploy A Model To An Endpoint
  - Used to demonstrate online predictions with feature store serving features

Overview:

Google Cloud Platform statmike-mlops Search products and resources

FEATURES & INFO SHORTCUT DISABLE EDITOR TABS

EDITOR DIGITS DIGITS\_LR DIGITS\_F...

COMPOSE NEW QUERY

Store.ipynb

Explorer + ADD DATA digits\_fs\_training

Type to search

SCHEMA DETAILS PREVIEW TABLE EXPLORER

Row timestamp entity\_type\_drawing target p0 p32 p16 p48 p8 p40 p24 p56 p4 p36 p20 p52 p12

1701	2021-09-14 21:04:52 UTC	a0c826c2-520d-46c1-aaef-461277eda3fa	6	0.0	0.0	0.0	0.0	0.0	0.0	15.0	16.0	2.0	6.0	11.0
1702	2021-09-14 21:04:52 UTC	226aaaf8b-d8ff-43c7-89ca-b289f4fa7f12	6	0.0	0.0	0.0	0.0	0.0	0.0	15.0	16.0	0.0	1.0	8.0
1703	2021-09-14 21:04:52 UTC	eefdf8f1f-3d1d-420c-a434-67cb01a6b8c0	6	0.0	0.0	0.0	0.0	0.0	0.0	16.0	16.0	0.0	8.0	10.0
1704	2021-09-14 21:04:52 UTC	40e40f54-7f9d-4ad1-a68b-3e7723008894	8	0.0	0.0	0.0	0.0	0.0	0.0	15.0	16.0	0.0	8.0	4.0
1705	2021-09-14 21:04:52 UTC	a7cd4041-fde9-4146-b1cc-299ea383545e	8	0.0	0.0	0.0	0.0	0.0	0.0	16.0	14.0	7.0	4.0	5.0
1706	2021-09-14 21:04:52 UTC	c4e06400-bdad-4267-85e7-d1eb5d24d1f5	8	0.0	0.0	0.0	0.0	0.0	0.0	14.0	15.0	1.0	4.0	10.0
1707	2021-09-14 21:04:52 UTC	cbfb03781-98be-4fbe-9d5c-bc8d71fc9a1	8	0.0	0.0	0.0	0.0	0.0	0.0	11.0	16.0	0.0	0.0	12.0
1708	2021-09-14 21:04:52 UTC	f6aab929-cc5b-407d-87a4-10a503df4d0b	8	0.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	4.0	1.0	5.0

digits\_fs\_training

QUERY ASK QUESTION SHARE COPY DELETE EXPORT

statmike-mlops digits Models (1) digits\_lr digits digits\_featurestore\_import digits\_prepended digits\_fs\_training digits\_prepended