Lecture 12: Advanced Training Workflows

AC215

Pavlos Protopapas
SEAS/ Harvard

Outline

1. Recap
2. Experiment Tracking
3. Tutorial: Experiment Tracking
4. Vertex AI, Serverless Training
5. Tutorial: Serverless Training
6. Multi GPU Training

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1. **Recap**
2. Experiment Tracking
3. Tutorial: Experiment Tracking
4. Vertex AI, Serverless Training
5. Tutorial: Serverless Training
6. Multi GPU Training

Recap: Motivation

The 3 components for better Deep Learning

More Data

- Extraction
- Transformation
- Labeling
- Versioning
- Storage

- Processing
- Input to Training

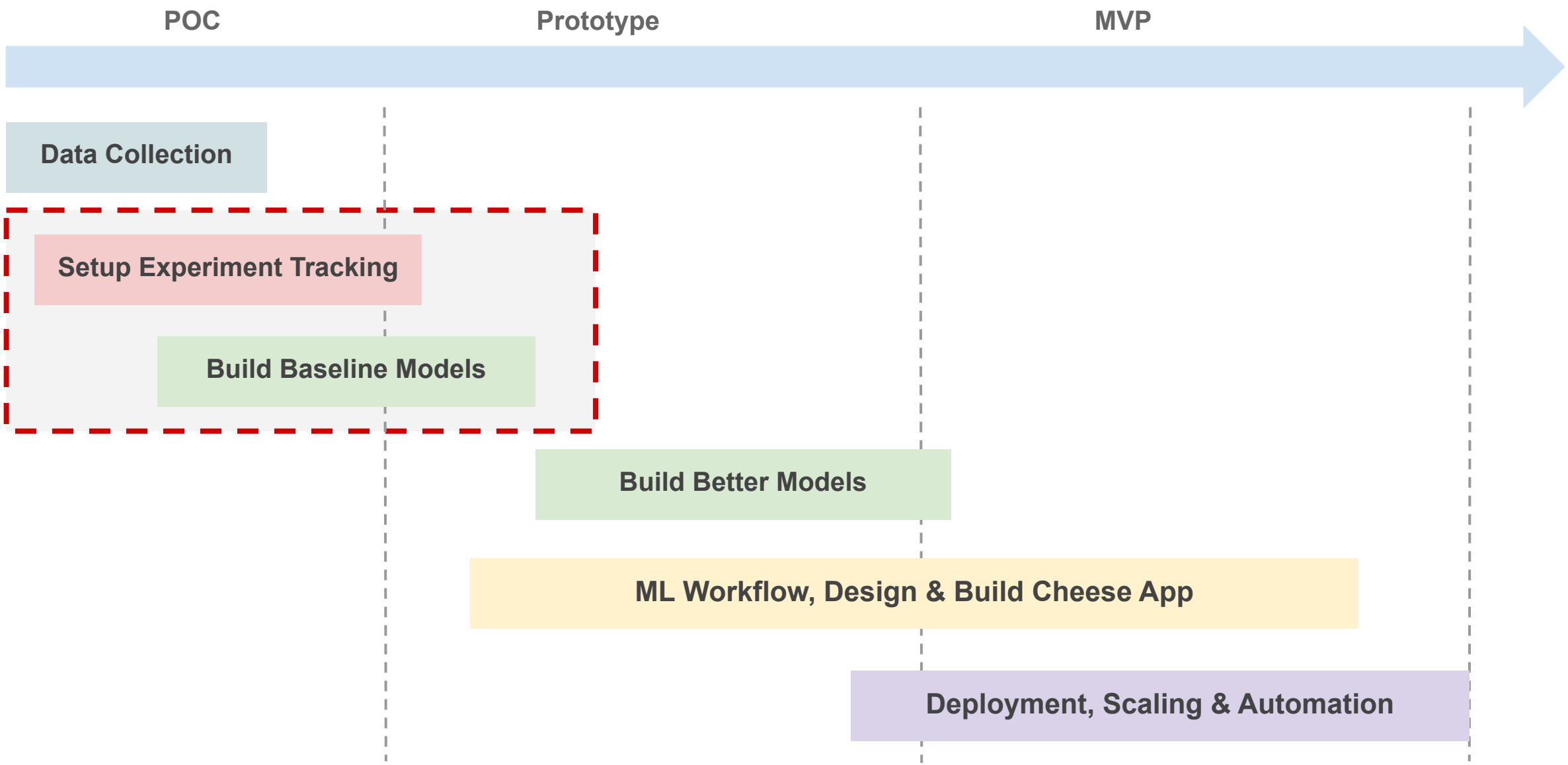
Better/Faster Models

- SOTA Models
- Transfer Learning
- Distillation
- Compression

Faster Hardware

- Scaling data processing
- GPU, TPU
- Multi GPU Server Training

Recap: Project Workflow



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Experiment Tracking

Why

- Organize your work (data collection/model training)
- Reproducibility
- Logging

Experiment Tracking

What

- Environments
- Scripts (Code)
- Data (version, train/validate/test split)
- Data pre-processing logic
- Model hyper parameters / configurations
- Evaluation metrics
- Model weights
- Performance results
- Sample predictions

Training Code

```
# Training Params
learning_rate = 0.001
batch_size = 32
epochs = 10

# Data
train_data, validation_data = get_dataset(...)
# Model
model = build_model(...)

# Train
training_results = model.fit(...)
```

Training Code using WandB

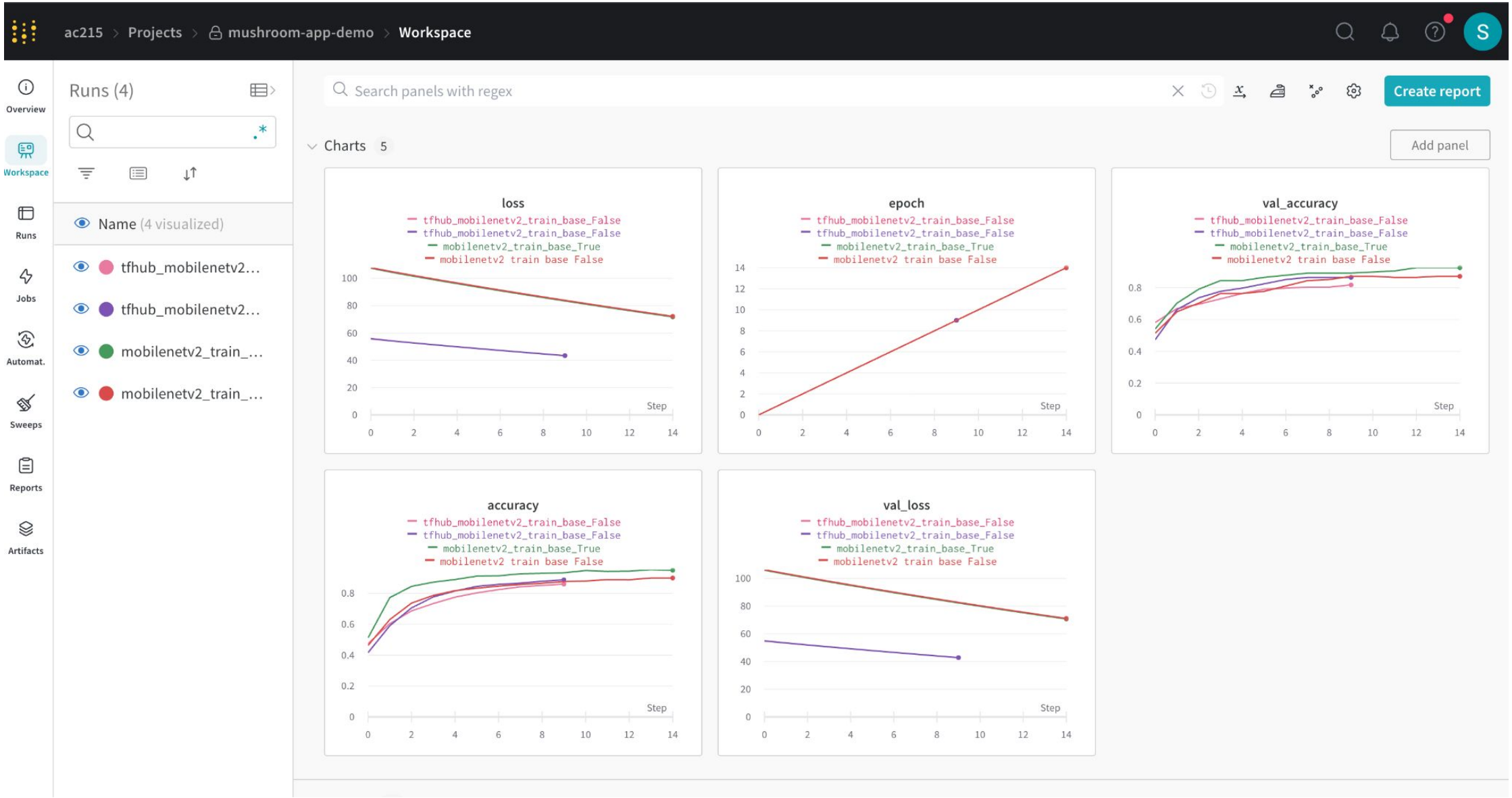
```
# Training Params
learning_rate = 0.001
batch_size = 32
epochs = 10

# Data
train_data, validation_data = get_dataset(...)
# Model
model = build_model(...)

# Initialize a W&B run
wandb.init(...)
# Train
training_results = model.fit(...,callbacks=[WandbCallback()])
# Close the W&B run
wandb.run.finish()
```

Initialize wandb run

Add a callback to monitor model

Let wandb know to finish the run

Experiment Tracking using WandB



Tutorial: Experiment Tracking

Goals of the tutorial are

- Explore models for cheese classifications

https://colab.research.google.com/drive/1GIslUzm62UsiDCWleLdANaNM-Z7JiExB

- Experiment Tracking using Weights & Bias

https://colab.research.google.com/drive/1VrNXEmfQnozPaV-aAWGIZ1Hm-NBEXOjk?usp=sharing

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5. Tutorial: Serverless Training
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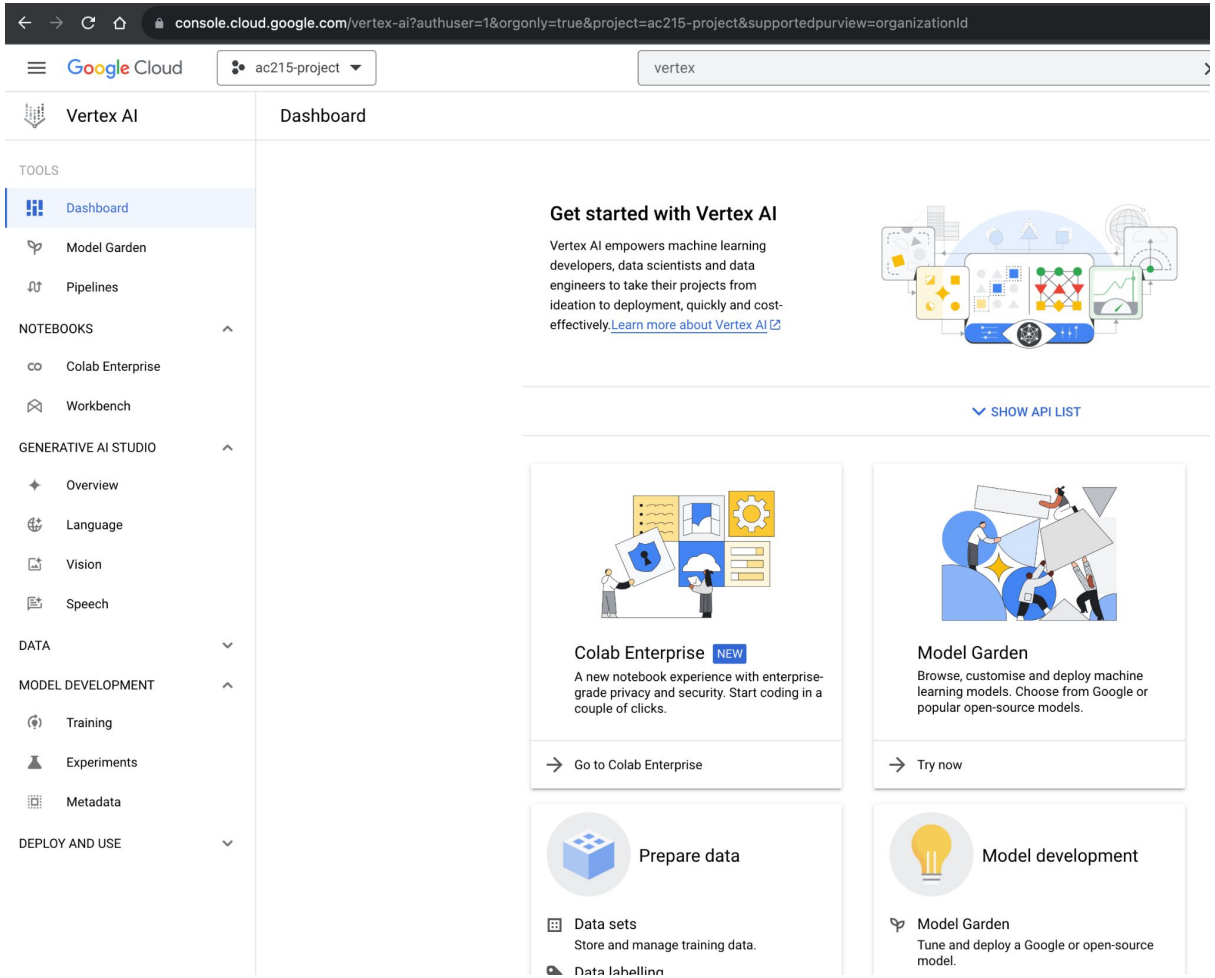
Vertex AI

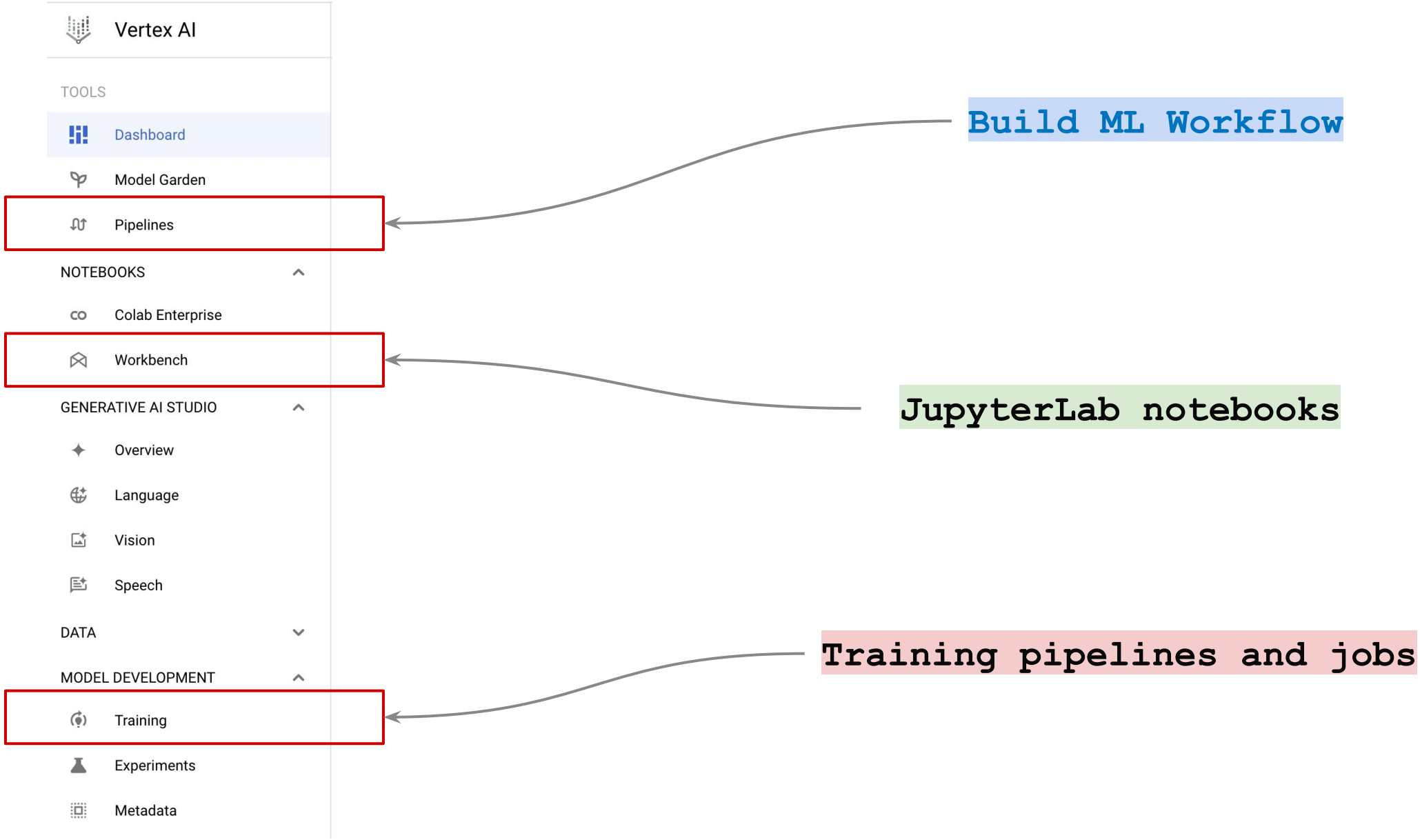
- Vertex AI is machine learning platform offered by Google in GCP.
- Vertex AI combines data engineering, data science, and ML engineering workflows, enabling your teams to collaborate using a common toolset and scale your applications using the benefits of Google Cloud.

Vertex AI

Vertex AI: https://console.cloud.google.com/vertex-ai



Vertex AI


Vertex AI
TOOLS
Dashboard
Model Garden
Pipelines
NOTEBOOKS
Colab Enterprise
Workbench
GENERATIVE AI STUDIO
Overview
Language
Vision
Speech
DATA
MODEL DEVELOPMENT
Training
Experiments
Metadata
Build ML Workflow
JupyterLab notebooks
Training pipelines and jobs

Serverless Training

What is serverless training?

- Execute training on an as-need basis
- Access GPU hardware only for the “training” step in a pipeline
- No setup of servers required
- Brings down training cost

Serverless Training

1 Move Code to Python File

Notebook

```
def get_dataset():
    ...
def get_model_1():
    ...
def get_model_2():
    ...
```

```
# Data
train_data, val_data = get_dataset(...)
# Model
model_1 = build_model_1(...)
# Train
training_results = model_1.fit(...)
```

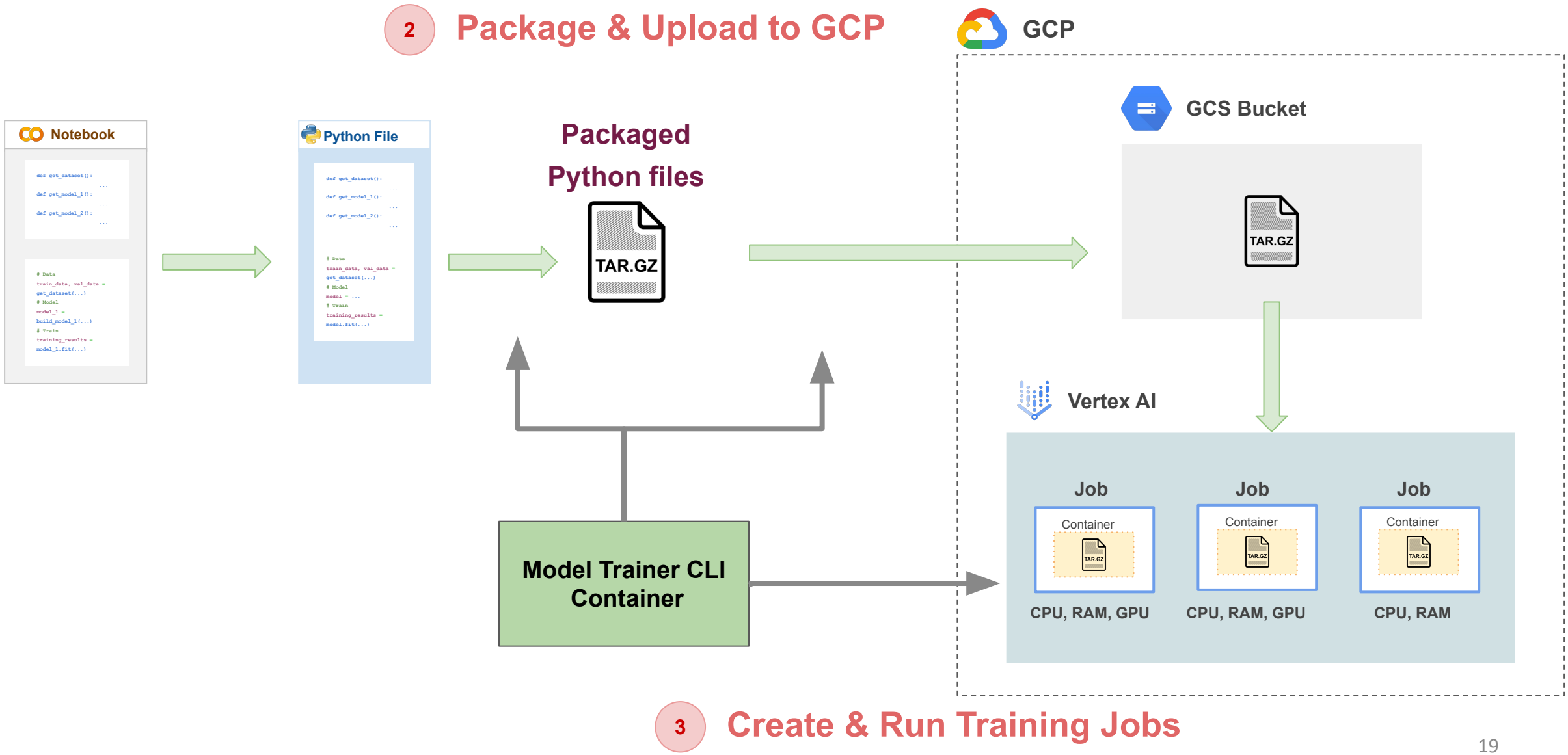
Python File

```
def get_dataset():
    ...
def get_model_1():
    ...
def get_model_2():
    ...

# Data
train_data, val_data = get_dataset(...)
# Model
model = ...
# Train
training_results = model.fit(...)
```

Pass Arguments: model=model_1 epochs=25 batch_size=32

Serverless Training



Tutorial: Serverless Training

Steps to perform **Serverless Training** on cheese classification models:

- Create a GCS bucket to store packaged python training code.
- Get Weights & Bias API Key for experiment tracking.
- Package & Upload python code.
- Create Jobs in Vertex AI.
- For detailed instructions, please refer to the following link
  - Serverless Training. (https://github.com/dlops-io/model-training)
  - View Training Jobs. (https://console.cloud.google.com/vertex-ai/training/custom-jobs)
  - View Experiment Metrics. (https://wandb.ai/home)

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Multi GPU Training

How do we perform distributed training?

- What type of distribution:
  - Single Machine, Single GPU [One Device Strategy]
  - Single Machine, Multiple GPUs [Mirrored Strategy]
  - Multiple Machine, Multiple GPUs [Multi Worker Mirrored Strategy]
- Organize code to apply the appropriate Strategy
- Train as usual

Training Code

```
# Training Params
learning_rate = 0.001
batch_size = 32
epochs = 10

# Data
train_data, validation_data = get_dataset(...)
# Model
model = build_model(...)

# Train
training_results = model.fit(...)
```

Training Code for Multi GPU

```
# Training Params
batch_size = 32
...
# Create distribution strategy
strategy = tf.distribute.MirroredStrategy()
num_workers = strategy.num_replicas_in_sync
# Data
train_data, validation_data = get_dataset(...,batch_size=batch_size * num_workers)
# Wrap model creation and compilation within scope of strategy
with strategy.scope():
    # Model
    model = build_model(...)

# Train
training_results = model.fit(...)
```

Create distribution Strategy

Adjust dataset batch size

Create & Compile model in strategy scope

Tutorial: Serverless Training - multi-GPU

Steps to perform **multi-GPU Serverless Training** on cheese classification models:

- Create a GCS bucket to store packaged python training code.
- Get Weights & Bias API Key for experiment tracking.
- Package & Upload python code.
- Create Jobs in Vertex AI using cli-multi-gpu.sh
- For detailed instructions, please refer to the following link
  - Serverless Training. (https://github.com/dlops-io/model-training?tab=readme-ov-file#optional-multi-gpu-training)

THANK YOU

Announcements / Reminders

- **Milestone 2 Due - 10/18 9PM EST**

Please add Staff GitHub Account - @ac2152024 (or ac215.2024@gmail.com) as collaborator (See Ed post)

Upcoming –

- **Guest Lecture - Modal Labs 10/24**

- **Milestone 3 - Midterm Presentations - 10/31** (Note: For some groups, presentations may begin and end 15-30 minutes later due to room availability.)

- **Showcase Time** 9:00 -11:00 AM - 12/09