



Example Kubeflow Operations and Tasks

NetApp Solutions

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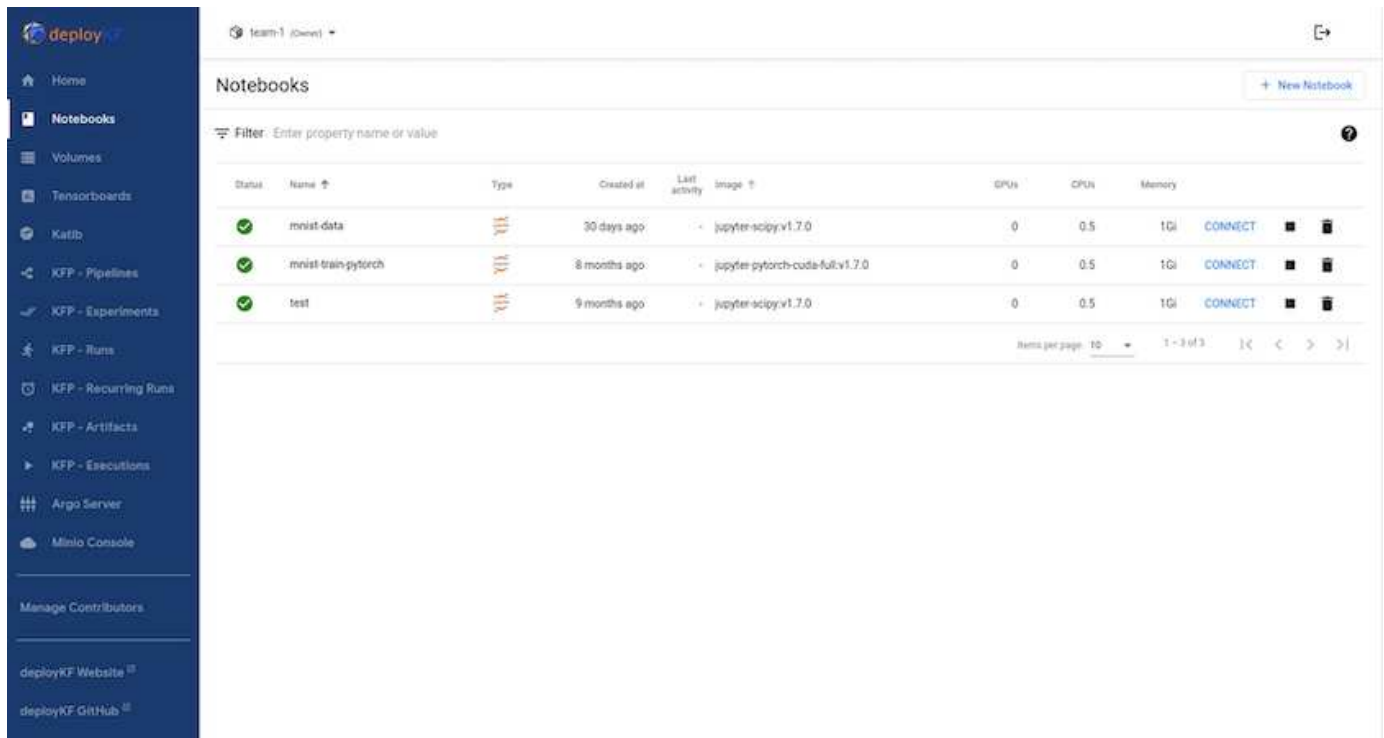
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Example Kubeflow Operations and Tasks

Provision a Jupyter Notebook Workspace for Data Scientist or Developer Use

Kubeflow is capable of rapidly provisioning new Jupyter Notebook servers to act as data scientist workspaces. For more information about Jupyter Notebooks within the Kubeflow context, see the [official Kubeflow documentation](#).



The screenshot shows the Kubeflow dashboard interface. On the left is a dark blue sidebar with navigation options: Home, Notebooks, Volumes, Tensorboards, Katib, KFP - Pipelines, KFP - Experiments, KFP - Runs, KFP - Recurring Runs, KFP - Artifacts, KFP - Executions, Argo Server, Minio Console, Manage Contributors, deployKF Website, and deployKF GitHub. The main content area is titled 'Notebooks' and includes a '+ New Notebook' button. Below this is a filter input field and a table of existing notebooks. The table has columns for Status, Name, Type, Created at, Last activity, Image, GPUs, CPUs, Memory, and actions (CONNECT, stop, delete). Three notebooks are listed: 'mnist-data' (created 30 days ago), 'mnist-train-pytorch' (created 8 months ago), and 'test' (created 9 months ago). All have a status of 'Running' and are using the 'jupyter-scipy/v1.7.0' image.

Status	Name	Type	Created at	Last activity	Image	GPUs	CPUs	Memory	Actions
Running	mnist-data	Jupyter Notebook	30 days ago		jupyter-scipy/v1.7.0	0	0.5	1Gi	CONNECT, stop, delete
Running	mnist-train-pytorch	Jupyter Notebook	8 months ago		jupyter-pytorch-cuda-full/v1.7.0	0	0.5	1Gi	CONNECT, stop, delete
Running	test	Jupyter Notebook	9 months ago		jupyter-scipy/v1.7.0	0	0.5	1Gi	CONNECT, stop, delete

Use the NetApp DataOps Toolkit with Kubeflow

The [NetApp Data Science Toolkit for Kubernetes](#) can be used in conjunction with Kubeflow. Using the NetApp Data Science Toolkit with Kubeflow provides the following benefits:

- Data scientists can perform advanced NetApp data management operations, such as creating snapshots and clones, directly from within a Jupyter Notebook.
- Advanced NetApp data management operations, such as creating snapshots and clones, can be incorporated into automated workflows using the Kubeflow Pipelines framework.

Refer to the [Kubeflow Examples](#) section within the NetApp Data Science Toolkit GitHub repository for details on using the toolkit with Kubeflow.

Example Workflow - Train an Image Recognition Model Using Kubeflow and the NetApp DataOps Toolkit

This section describes the steps involved in training and deploying a Neural Network for Image Recognition using Kubeflow and the NetApp DataOps Toolkit. This is intended to serve as an example to show a training job that incorporates NetApp storage.

Prerequisites

Create a Dockerfile with the required configurations to use for the train and test steps within the Kubeflow pipeline.

Here is an example of a Dockerfile -

```
FROM pytorch/pytorch:latest
RUN pip install torchvision numpy scikit-learn matplotlib tensorboard
WORKDIR /app
COPY . /app
COPY train_mnist.py /app/train_mnist.py
CMD ["python", "train_mnist.py"]
```

Depending on your requirements, install all required libraries and packages needed to run the program. Before you train the Machine Learning model, it is assumed that you already have a working Kubeflow deployment.

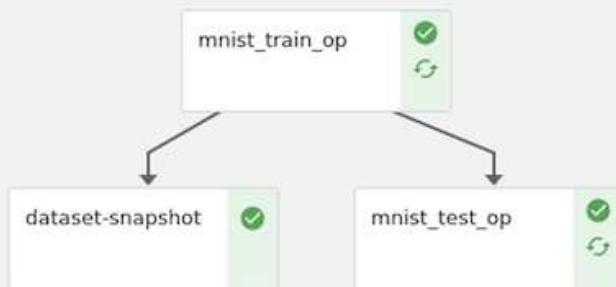
Train a Small NN on MNIST Data Using PyTorch and Kubeflow Pipelines

We use the example of a small Neural Network trained on MNIST data. The MNIST dataset consists of handwritten images of digits from 0-9. The images are 28x28 pixels in size. The dataset is divided into 60,000 train images and 10,000 validation images. The Neural Network used for this experiment is a 2-layer feedforward network. Training is executed using Kubeflow Pipelines. Refer to the documentation [here](#) for more information. Our Kubeflow pipeline incorporates the docker image from the Prerequisites section.

[←](#) ✔ mnist_pipeline 2024-04-03 15-57-35**Graph**

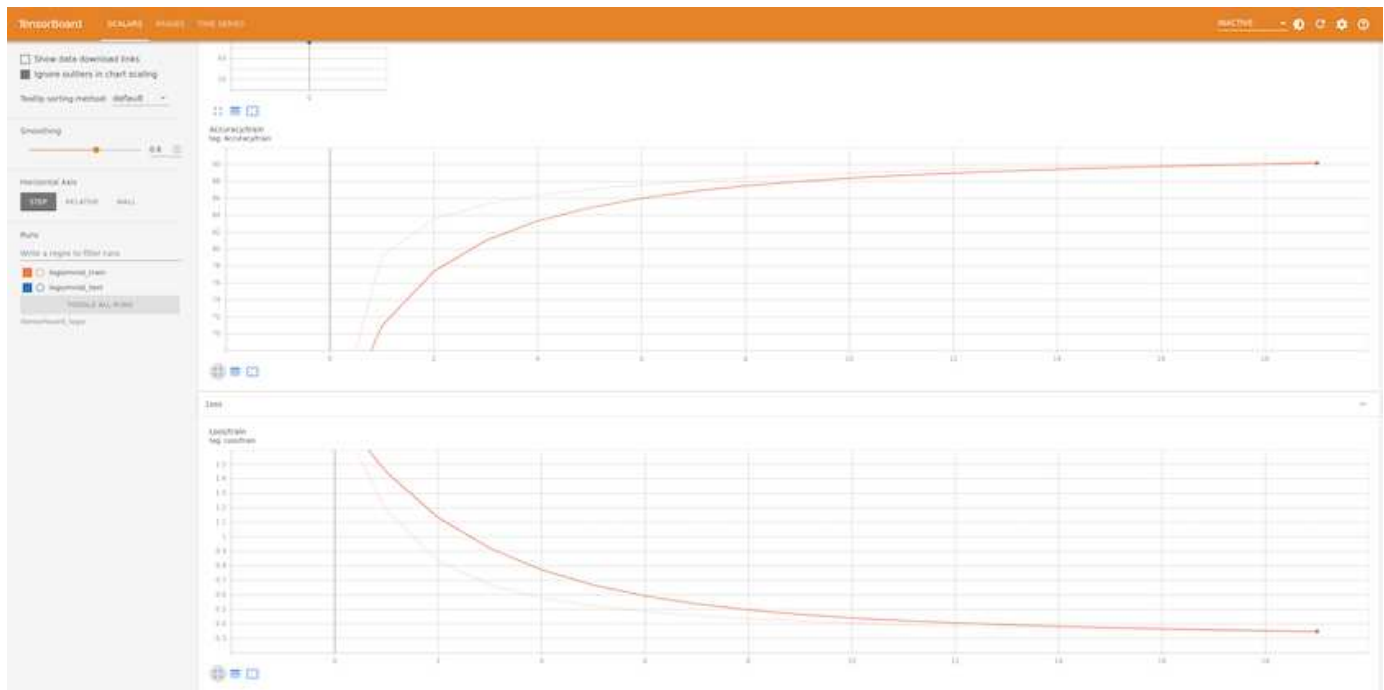
Run output

Config

 Simplify Graph

Visualize Results Using Tensorboard

Once the model is trained, we can visualize the results using Tensorboard. [Tensorboard](#) is available as a feature on the Kubeflow Dashboard. You can create a custom tensorboard for your job. An example below shows the plot of training accuracy vs. number of epochs and training loss vs. number of epochs.



Experiment with Hyperparameters Using Katib

Katib is a tool within KubeFlow that can be used to experiment with the model hyperparameters. To create an experiment, define a desired metric/goal first. This is usually the test accuracy. Once the metric is defined, choose hyperparameters that you would like to play around with (optimizer/learning_rate/number of layers). Katib does a hyperparameter sweep with the user-defined values to find the best combination of parameters that satisfy the desired metric. You can define these parameters in each section in the UI. Alternatively, you could define a **YAML** file with the necessary specifications. Below is an illustration of a Katib experiment -

team-1 (Owner) ↗

← Experiment details DELETE

Objective

Name	Validation-accuracy
Type	maximize
Goal	0.9
Additional metrics	Train-accuracy

Trials

Max failed trials	3
Max trials	12
Parallel trials	3

Parameters

lr Parameter type: double Min: 0.01 Max: 0.03

num-layers Parameter type: int Min: 1 Max: 64

optimizer Parameter type: categorical sgd, adam, ftrl

Algorithm

Name	grid
------	------

Metrics collector

Collector type	File
----------------	------

team-1 (Owner) ↗

← Experiment details DELETE

! Couldn't find any successful Trial.

OVERVIEW TRIALS DETAILS YAML

Name	mnist-gytorch
Status	🕒 Experiment is running
Best trial	No optimal trial yet
Best trial's params	No optimal trial yet
Best trial performance	Validation-accuracy > 0.9
User defined goal	Validation-accuracy > 0.9
Running trials	3
Failed trials	0
Succeeded trials	0

Experiment Conditions

Filter Enter property name or value ?

Use NetApp Snapshots to Save Data for Traceability

During the model training, we may want to save a snapshot of the training dataset for traceability. To do this,

we can add a snapshot step to the pipeline as shown below. To create the snapshot, we can use the [NetApp DataOps Toolkit for Kubernetes](#).

```
@dsl.pipeline(
    name = 'MNIST Classification Pipeline',
    description = 'Train a simple NN for classification'
)
def mnist_pipeline():
    mnist_train_task = mnist_train_op()
    mnist_train_task.apply(
        kfp.onprem.mount_pvc('mnist-data', 'mnist-data-vol', '/mnt/data/')
    )

    mnist_test_task = mnist_test_op()
    mnist_test_task.apply(
        kfp.onprem.mount_pvc('mnist-data', 'mnist-data-vol', '/mnt/data/')
    )

    volume_snapshot_name = "mnist-pytorch-snapshot"
    dataset_snapshot = dsl.ContainerOp(
        name="dataset-snapshot",
        image="python:3.9",
        command=["/bin/bash", "-c"],
        arguments=["\
            python3 -m pip install netapp-dataops-k8s && \
            echo "" + volume_snapshot_name + "" > /volume_snapshot_name.txt && \
            netapp_dataops_k8s_cli.py create volume-snapshot --pvc-name=" + "mnist-data" + " --snapshot-name=" + str(volume_snapshot_name) + " --namespace={workflow.namespace}"],
        file_outputs={"volume_snapshot_name": "/volume_snapshot_name.txt"}
    )
    mnist_test_task.after(mnist_train_task)
    dataset_snapshot.after(mnist_train_task)
```

Refer to the [NetApp DataOps Toolkit example for KubeFlow](#) for more information.

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