Google Cloud

AutoMLOps

From Notebooks to Pipelines in Minutes

Implementation Guide v1.0.2

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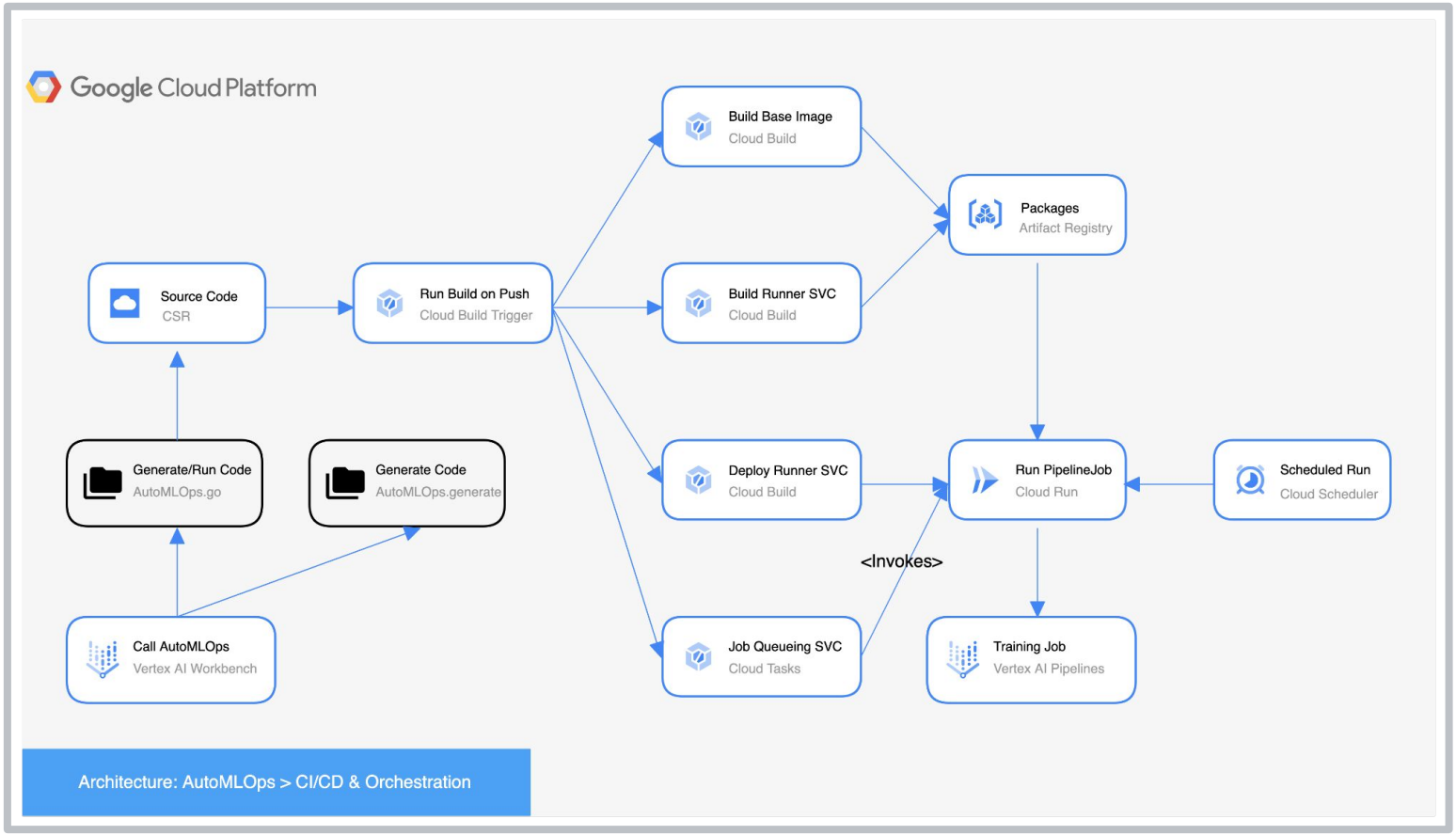
February 2023

Solution Overview



Set Up

Prerequisites / Assumptions

The prerequisites for use of AutoMLOps are as follows:

- Jupyter (or Jupyter-compatible) notebook environment
- Notebooks API is enabled
- Python version ≥3.0 and ≤3.10
- Google Cloud SDK 407.0.0
- gcloud beta 2022.10.21
- git is installed and logged-in

```
git config --global user.email "you@example.com"
git config --global user.name "Your Name"
```

- Application Default Credentials (ADC) are set up, which can be done through the following commands:

```
gcloud auth application-default login
gcloud config set account <account@example.com>
```

Set Up AutoMLOps Package

1. Clone the repo:

```
git clone https://github.com/GoogleCloudPlatform/AutoMLOps.git
```

2. Install the AutoMLOps package:

```
pip install dist/AutoMLOps-1.0.2-py2.py3-none-any.whl
```

3. Open a notebook and import the AutoMLOps package:

```
from AutoMLOps import AutoMLOps
```

4. Decide whether to use Kubeflow definitions or Python definitions

Using Python Components (no Kubeflow)

AutoMLOps Python Process

1. Define import code cells

```
%%define_imports
import json
import pandas as pd
from google.cloud import aiplatform
from google.cloud import aiplatform_v1
from google.cloud import bigquery
...
```

AutoMLOps Python Process

2. Define component code cells

```
%%define_component
AutoMLOps.makeComponent(
   name = "create_dataset",
   description = "Loads data from BQ and writes a dataframe as a csv to GCS.", # optional
   params = [
       {"name": "bq_table", "type": str}, # descriptions are optional
       {"name": "data_path", "type": str, "description": "GS location where the training data is written."},
       {"name": "project_id", "type": str, "description": "Project_id."}
   ]
)
```

AutoMLOps Python Process

3. Define pipeline code cell

```
AutoMLOps.makePipeline(
    name = "training-pipeline",
    description = "description", # optional
    params = [
        {"name": "bq_table", "type": str}, # descriptions are optional
        {"name": "model_directory", "type": str, "description": "Description."},
        {"name": "data_path", "type": str, "description": "Description."},
        {"name": "project_id", "type": str, "description": "Description."},
        {"name": "region", "type": str, "description": "Description."}
    ],
    pipeline = [{
        "component_name": "create_dataset", "param_mapping": [
            ("bq_table", "bq_table"), # (component_param, pipeline_param)
            ("data_path", "data_path"),
            ("project_id", "project_id")
        ]
    },
    {
        "component_name": "train_model", "param_mapping": [
            ("model_directory", "model_directory"),
            ("data_path", "data_path")
        ]
    },
    {
        "component_name": "deploy_model", "param_mapping": [
            ("model_directory", "model_directory"),
            ("project_id", "project_id"),
            ("region", "region")
        ]
    }]
)
```

AutoMLOps Python Process

4. Define the pipeline parameters dictionary

```
pipeline_params = {
    "bq_table": f"{PROJECT_ID}.test_dataset.dry-beans",
    "model_directory": f"gs://{PROJECT_ID}-bucket/trained_models/{datetime.datetime.now()}",
    "data_path": f"gs://{PROJECT_ID}-bucket/data",
    "project_id": f"{PROJECT_ID}",
    "region": "us-central1"
}
```

AutoMLOps Python Process

5. Call ***AutoMLOps.generate()*** to create the resources and repository

   Or ***AutoMLOps.go()*** to call generate in addition to building/submitting the pipeline job

```
AutoMLOps.generate(project_id = PROJECT_ID,
                   pipeline_params = pipeline_params,
                   use_kfp_spec = False,
                   run_local = True)

AutoMLOps.go(project_id = PROJECT_ID,
             pipeline_params = pipeline_params,
             use_kfp_spec = False,
             run_local = True)
```

   Set ***use_kfp_spec=False*** when using an AutoMLOps Python defined pipeline

   Set ***run_local=False*** if you want to generate and use CI/CD features

Using Kubeflow Components

AutoMLOps Kubeflow Process

1. Define your components using KFP

```
@component(
   packages_to_install = [
       "google-cloud-bigquery",
       "pandas",
       "pyarrow",
       "db_dtypes"
   ],
   base_image = "python:3.9",
   output_component_file = f"{AutoMLOps.OUTPUT_DIR}/create_dataset.yaml"
)
def create_dataset(
   bq_table: str,
   output_data_path: OutputPath("Dataset"),
   project: str
):
   from google.cloud import bigquery
...
```

AutoMLOps Kubeflow Process

2. If using Kubeflow defs, define your pipeline using KFP and AutoMLOps:

```
%%define_kfp_pipeline

@dsl.pipeline(name = 'training-pipeline')
def pipeline(bq_table: str,
             output_model_directory: str,
             project: str,
             region: str,
            ):

   dataset_task = create_dataset(
       bq_table = bq_table,
       project = project)

   model_task = train_model(
       output_model_directory = output_model_directory,
       dataset = dataset_task.output)

   deploy_task = deploy_model(
       model = model_task.outputs["model"],
       project = project,
       region = region)
...
```

AutoMLOps Kubeflow Process

3. Define the pipeline parameters dictionary

```
pipeline_params = {
   "bq_table": f"{PROJECT_ID}.test_dataset.dry-beans",
   "output_model_directory": f"gs://{PROJECT_ID}-bucket/trained_models/{datetime.datetime.now()}",
   "project": f"{PROJECT_ID}",
   "region": "us-central1"
}
```

AutoMLOps Kubeflow Process

4. Call ***AutoMLOps.generate()*** to create the resources and repository

   Or ***AutoMLOps.go()*** to call generate in addition to building/submitting the pipeline job

```
AutoMLOps.generate(project_id = PROJECT_ID,
                   pipeline_params = pipeline_params,
                   use_kfp_spec = True,
                   run_local = False)

AutoMLOps.go(project_id = PROJECT_ID,
             pipeline_params = pipeline_params,
             use_kfp_spec = True,
             run_local = False)
```

Set ***use_kfp_spec=True*** when using a Kubeflow defined pipeline

Set ***run_local=False*** if you want to generate and use CI/CD features

Customizations

AutoMLOps Defaults

There are a number of custom parameters that can be configured. To the left is a list of the default parameters:

```
AutoMLOps.go(project_id=PROJECT_ID, # required
             pipeline_params=pipeline_params, # required
             af_registry_location='us-central1', # default
             af_registry_name='vertex-mlops-af', # default
             cb_trigger_location='us-central1', # default
             cb_trigger_name='automlops-trigger', # default
             cloud_run_location='us-central1', # default
             cloud_run_name='run-pipeline', # default
             cloud_tasks_queue_location='us-central1', # default
             cloud_tasks_queue_name='queueing-svc', # default
             csr_branch_name='automlops', # default
             csr_name='AutoMLOps-repo', # default
             custom_training_job_specs=None, # default
             gs_bucket_location='us-central1', # default
             gs_bucket_name=None, # default
             pipeline_runner_sa=None, # default
             run_local=True, # default
             schedule_location='us-central1', # default
             schedule_name='AutoMLOps-schedule', # default
             schedule_pattern='No Schedule Specified', # default
             use_kfp_spec=False, # default
             vpc_connector='No VPC Specified' # default)
```

AutoMLOps Defaults

- `project_id`: The project ID.
- `pipeline_params`: Dictionary containing runtime pipeline parameters.
- `af_registry_location`: Region of the Artifact Registry.
- `af_registry_name`: Artifact Registry name where components are stored.
- `cb_trigger_location`: The location of the cloudbuild trigger.
- `cb_trigger_name`: The name of the cloudbuild trigger.
- `cloud_run_location`: The location of the cloud runner service.
- `cloud_run_name`: The name of the cloud runner service.
- `cloud_tasks_queue_location`: The location of the cloud tasks queue.
- `cloud_tasks_queue_name`: The name of the cloud tasks queue.
- `csr_branch_name`: The name of the csr branch to push to to trigger cb job.
- `csr_name`: The name of the cloud source repo to use.
- `custom_training_job_specs`: Specifies the specs to run the training job with.
- `gs_bucket_location`: Region of the GS bucket.
- `gs_bucket_name`: GS bucket name where pipeline run metadata is stored.
- `pipeline_runner_sa`: Service Account to runner PipelineJobs.
- `run_local`: Flag that determines whether to use Cloud Run CI/CD.
- `schedule_location`: The location of the scheduler resource.
- `schedule_name`: The name of the scheduler resource.
- `schedule_pattern`: Cron formatted value used to create a Scheduled retrain job.
- `use_kfp_spec`: Flag that specifies whether you are using Kubeflow spec or not.
- `vpc_connector`: The name of the vpc connector to use.

AutoMLOps Set Scheduled Run

Use the ***schedule_pattern*** parameter to specify a cron job schedule to run the pipeline job on a recurring basis.

The ***run_local*** must be set to ***False*** to make use of this feature.

```
AutoMLOps.generate(project_id = PROJECT_ID,
                   pipeline_params = pipeline_params,
                   use_kfp_spec = False,
                   run_local = False,
                   schedule_pattern = '0 */12 * * *')
```

The above example will rerun the pipeline every 12 hours.

AutoMLOps Set Pipeline Compute Resources

Use the ***custom_training_job_specs*** parameter to specify resources for any custom component in the pipeline.

The ***component_spec*** must match exactly the name of the custom component.

```
AutoMLOps.generate(project_id = PROJECT_ID,
                   pipeline_params = pipeline_params,
                   use_kfp_spec = False,
                   run_local = False,
                   custom_training_job_specs = [{
                      'component_spec': 'train_model',
                      'display_name': 'train-model-accelerated',
                      'machine_type': 'a2-highgpu-1g',
                      'accelerator_type': 'NVIDIA_TESLA_A100',
                      'accelerator_count': '1'
                   }])
```

The example above uses a GPU for accelerated training. See Machine types and GPUs for more info.

The ***custom_training_job_specs*** parameter takes in any key-value pair available under

google_cloud_pipeline_components.v1.custom_job.create_custom_training_job_op_from_component

AutoMLOps VPC Connector

Use the ***vpc_connector*** parameter to specify a vpc connector.

```
AutoMLOps.generate(project_id = PROJECT_ID,
                   pipeline_params = pipeline_params,
                   use_kfp_spec = False,
                   run_local = False,
                   vpc_connector = 'example-vpc')
```

Behind the Scenes

Cloud Resources

When the pipeline is run, the following resources are created to complete the MLOps pipeline:

1. AutoMLOps codebase
2. Artifact Registry
3. GS Bucket
4. Pipeline Runner Service Account
5. Cloud Source Repository (turns the notebooks working directory into a CSR)
6. Cloud Build Trigger
7. Cloud Runner Service
8. Cloud Scheduler
9. Cloud Tasks queue

APIs

When the pipeline is run, the following APIs are enabled:

1. cloudresourcemanager.googleapis.com
2. aiplatform.googleapis.com
3. artifactregistry.googleapis.com
4. cloudbuild.googleapis.com
5. cloudscheduler.googleapis.com
6. cloudtasks.googleapis.com
7. compute.googleapis.com
8. iam.googleapis.com
9. iamcredentials.googleapis.com
10. ml.googleapis.com
11. run.googleapis.com
12. storage.googleapis.com
13. sourcerepo.googleapis.com

IAM Access

When the pipeline is run, the following IAM access roles are updated:

1. **Pipeline Runner Service Account** (created if it does exist, defaults to: *vertex-pipelines@<PROJECT_ID>.iam.gserviceaccount.com*).

   Roles added:

   - roles/aiplatform.user
   - roles/artifactregistry.reader
   - roles/bigquery.user
   - roles/bigquery.dataEditor
   - roles/iam.serviceAccountUser
   - roles/storage.admin
   - roles/run.admin

2. **Cloudbuild Default Service Account** (*<PROJECT_NUMBER>@cloudbuild.gserviceaccount.com*).

   Roles added:

   - roles/run.admin
   - roles/iam.serviceAccountUser
   - roles/cloudtasks.enqueuer
   - roles/cloudscheduler.admin

Package Dependencies

When using AutoMLOps, the following package versions are used:

1. autoflake==2.0.0,
2. docopt==0.6.2,
3. ipython==7.34.0,
4. pipreqs==0.4.11,
5. pyflakes==3.0.1,
6. PyYAML==5.4.1,
7. yarg==0.1.9