Google Cloud

# AutoMLOps

*From Notebooks to Pipelines in Minutes*

**Implementation Guide v1.0.5**

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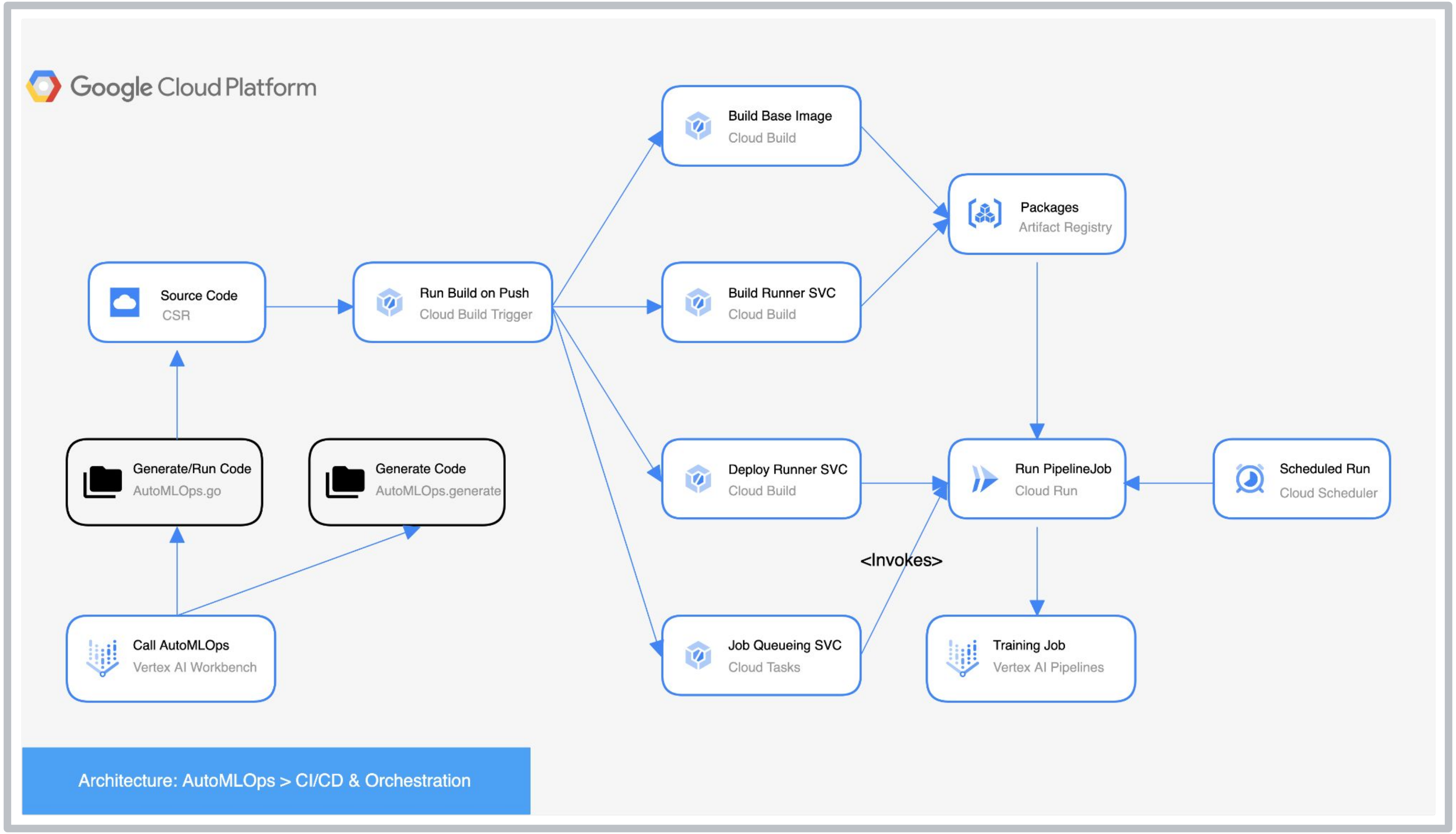
# Solution Overview



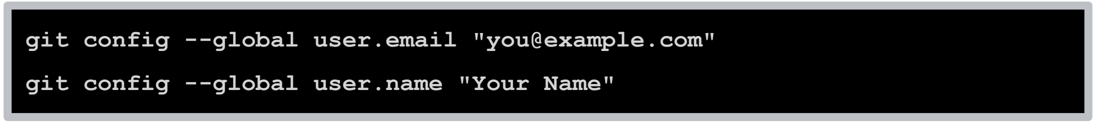
## Set Up

Google Cloud

# Prerequisites / Assumptions

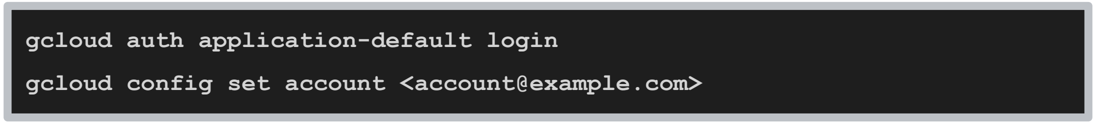
*The prerequisites for use of AutoMLOps are as follows:*

- 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. Install the AutoMLOps package:

```
pip install google-cloud-automlops
```

2. Open a notebook and import the AutoMLOps package:

```
from AutoMLOps import AutoMLOps
```

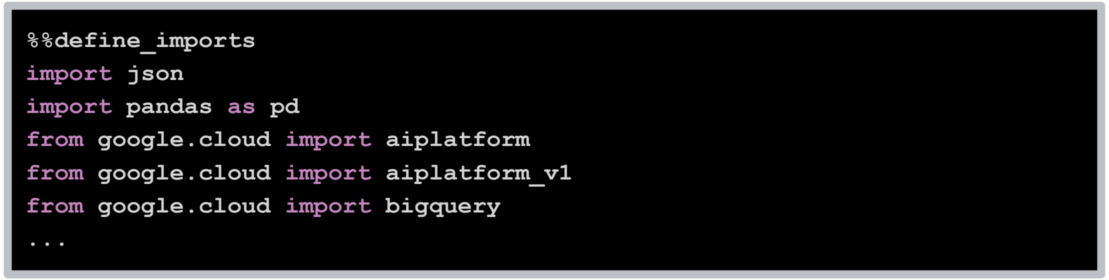
3. Decide whether to use Kubeflow definitions or Python definitions

# Using Python Components (no Kubeflow)

Google Cloud

# AutoMLOps Python Process

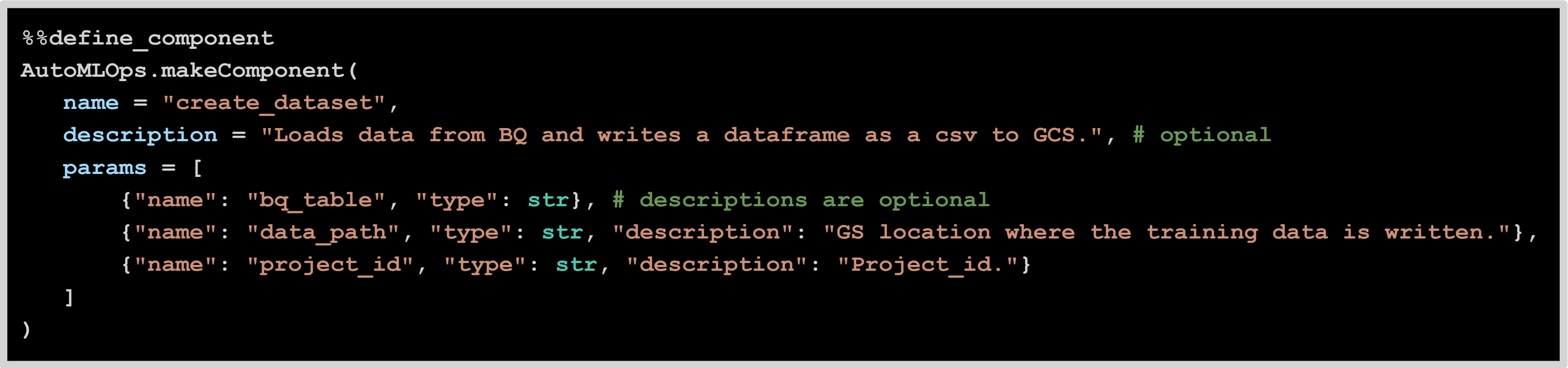
1. Define import code cells



```
%%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

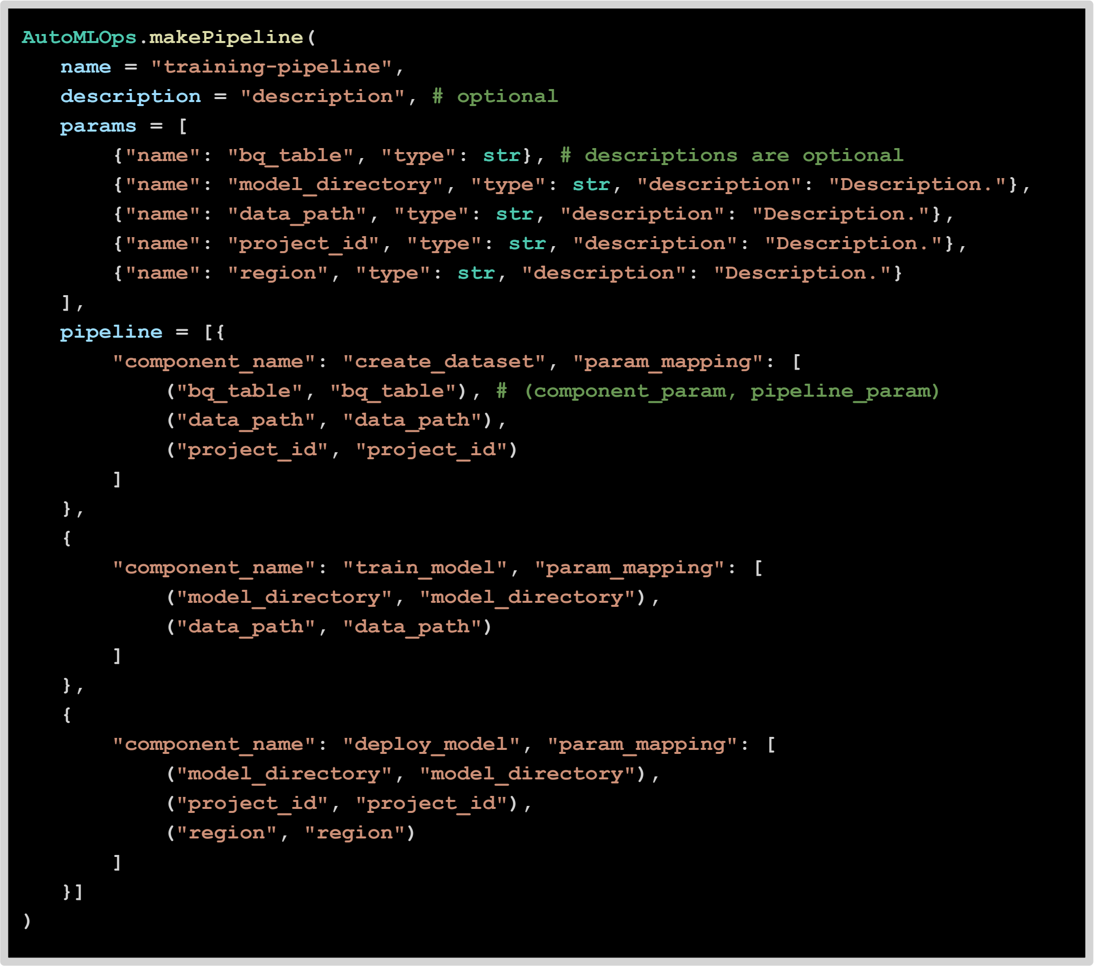
2. Define component code cells



```
%%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

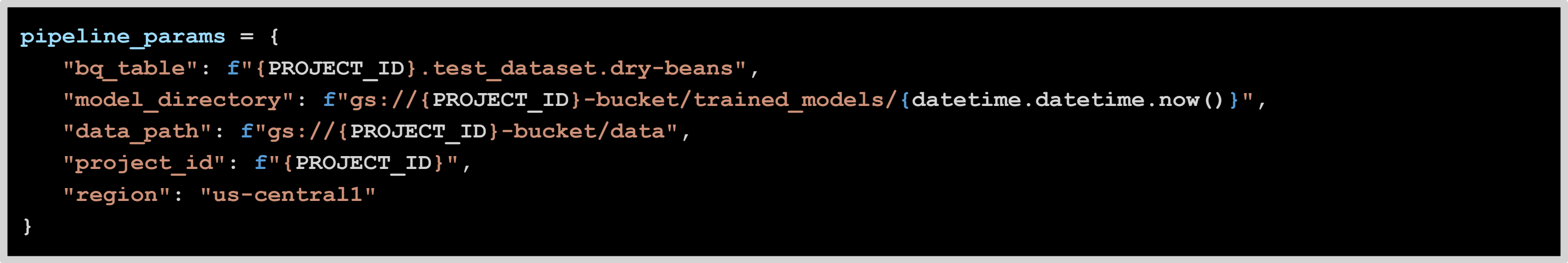
3. Define pipeline code cell



```
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

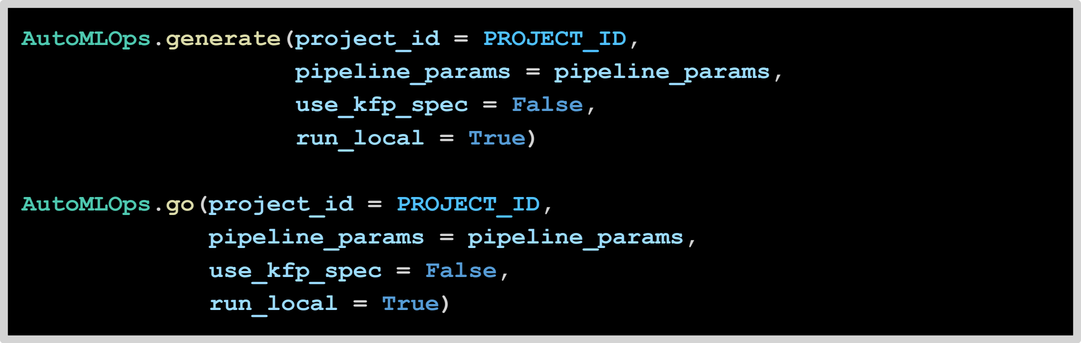


```
pipeline_params = {
    "bq_table": f"{PROJECT_ID}.test_dataset.dry-beans",
    "model_directory": f"gs://{PROJECT_ID}-bucket/trained_models/{datetime.datetime.now()}",
    "data_path": f"gs://{PROJECT_ID}-bucket/data",
    "project_id": f"{PROJECT_ID}",
    "region": "us-central1"
}
```

# 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

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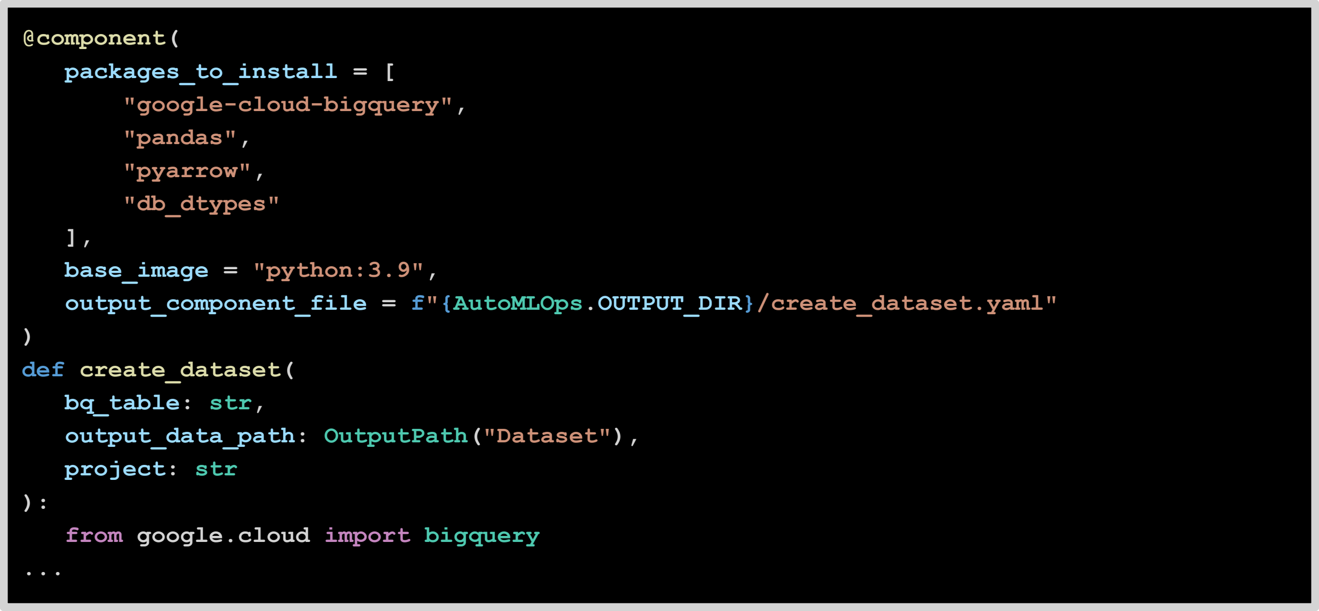
# AutoMLOps Kubeflow Process

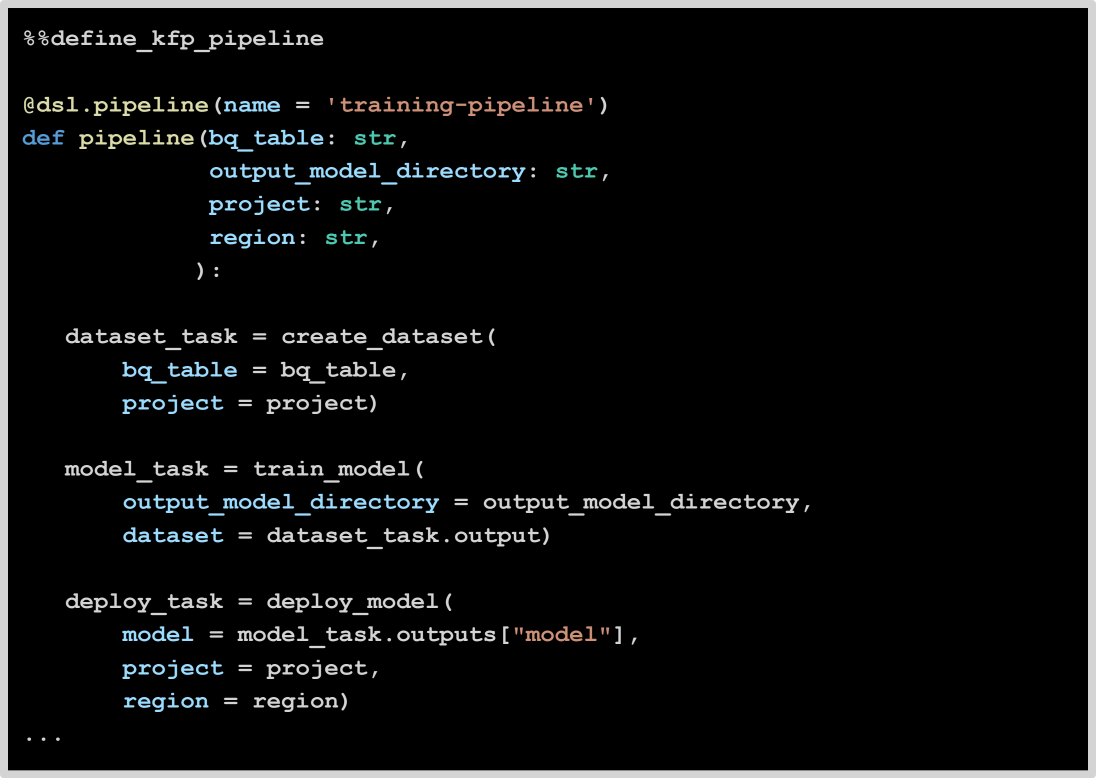
1. Define your components using KFP



```
@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

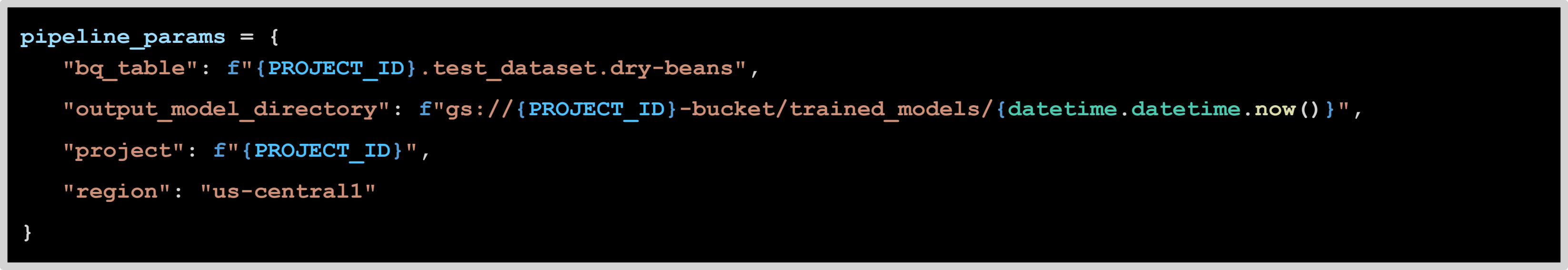
2. If using Kubeflow defs, define your pipeline using KFP and AutoMLOps:



```
%%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

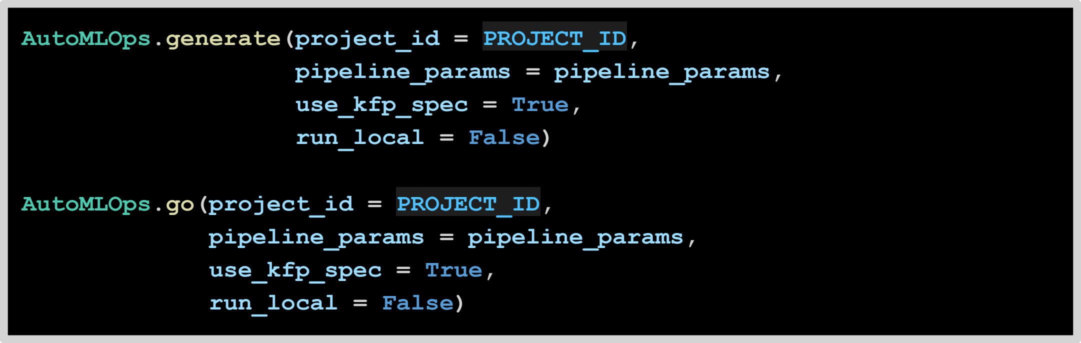


```
pipeline_params = {
   "bq_table": f"{PROJECT_ID}.test_dataset.dry-beans",

   "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

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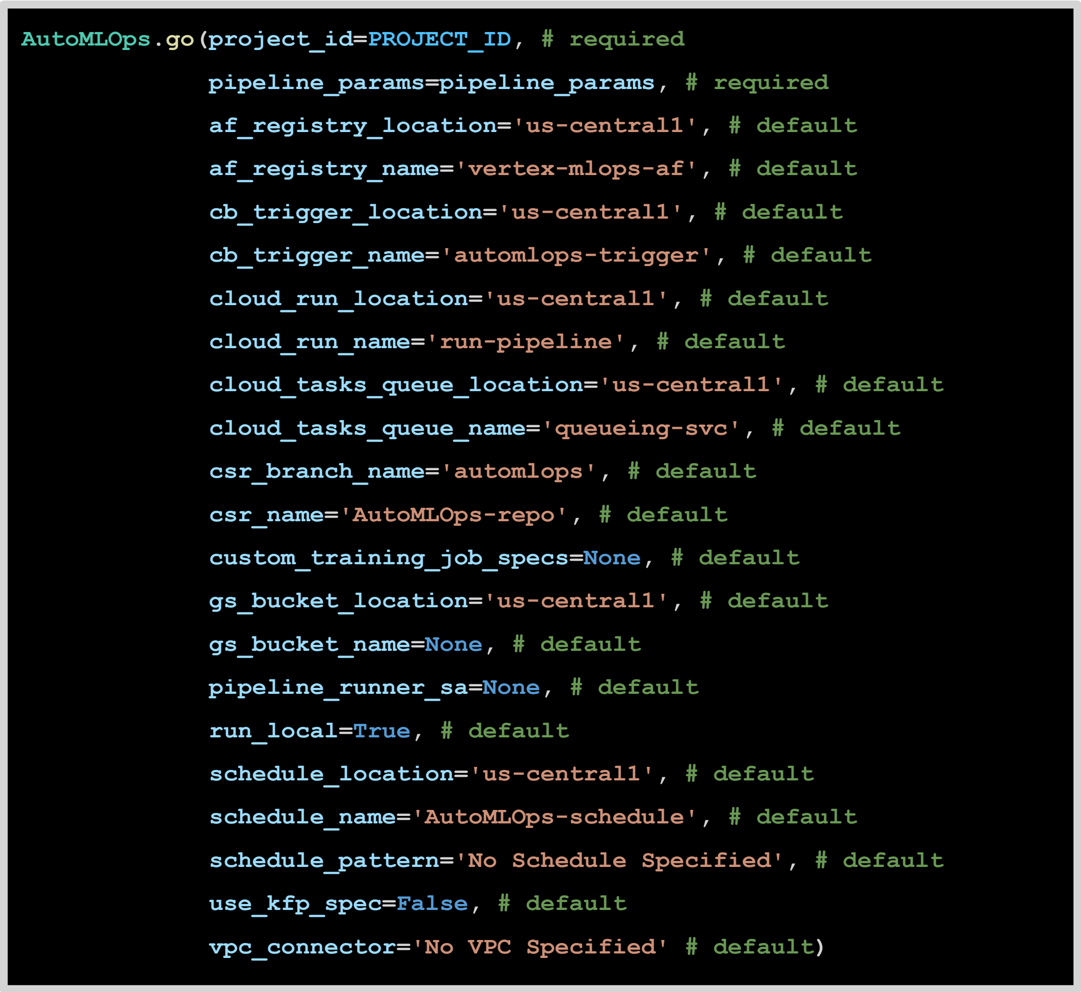
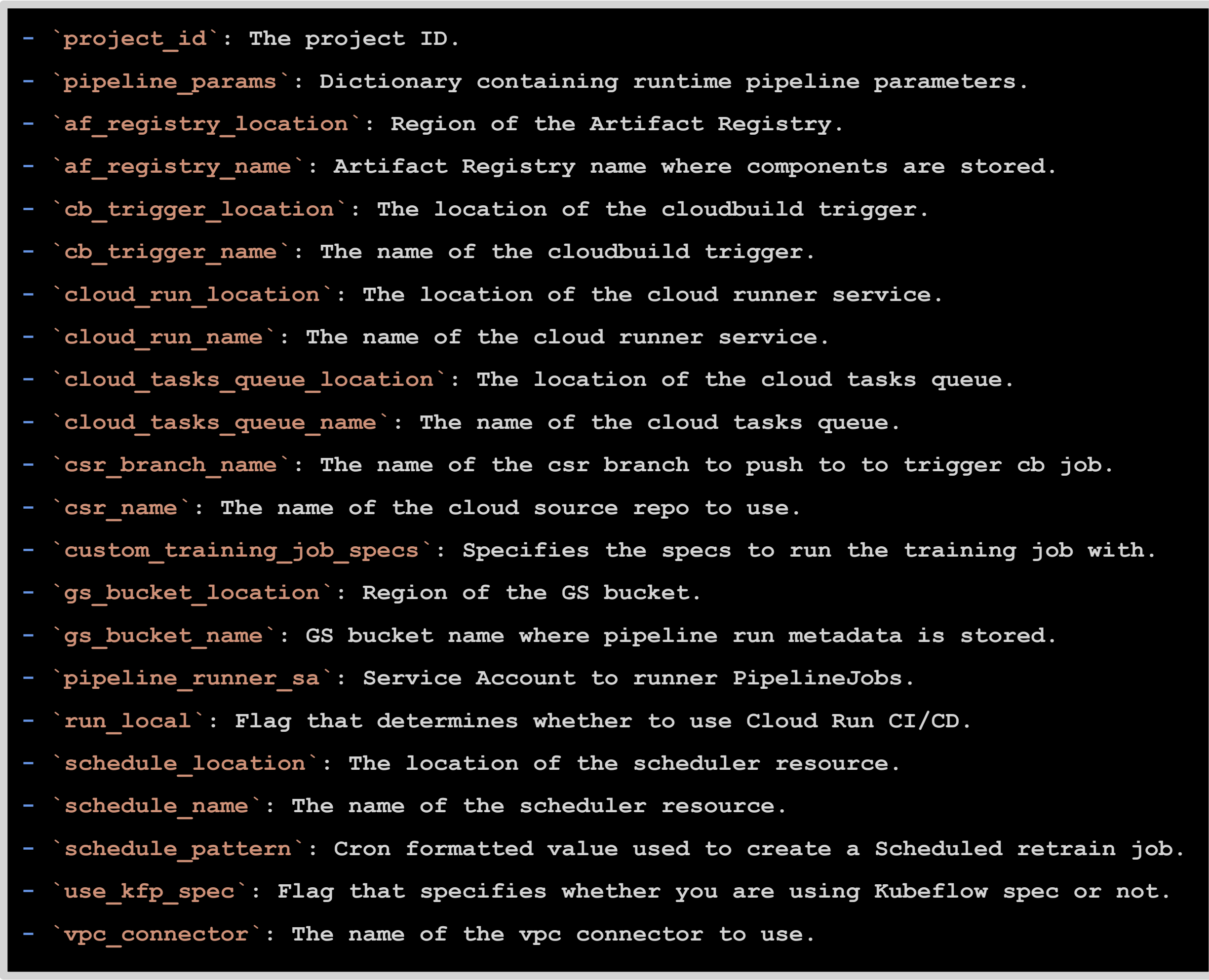
# AutoMLOps Defaults

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

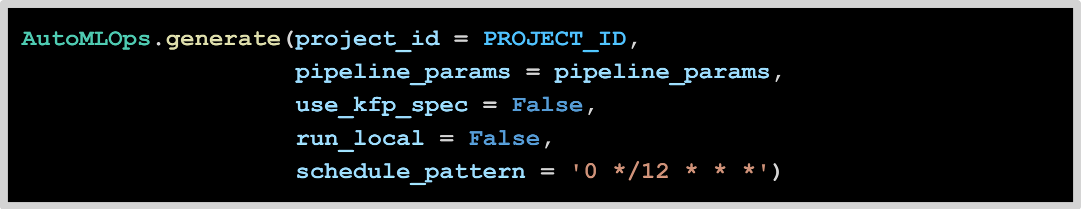


```
- `project_id`: The project ID.
- `pipeline_params`: Dictionary containing runtime pipeline parameters.
- `af_registry_location`: Region of the Artifact Registry.
- `af_registry_name`: Artifact Registry name where components are stored.
- `cb_trigger_location`: The location of the cloudbuild trigger.
- `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.



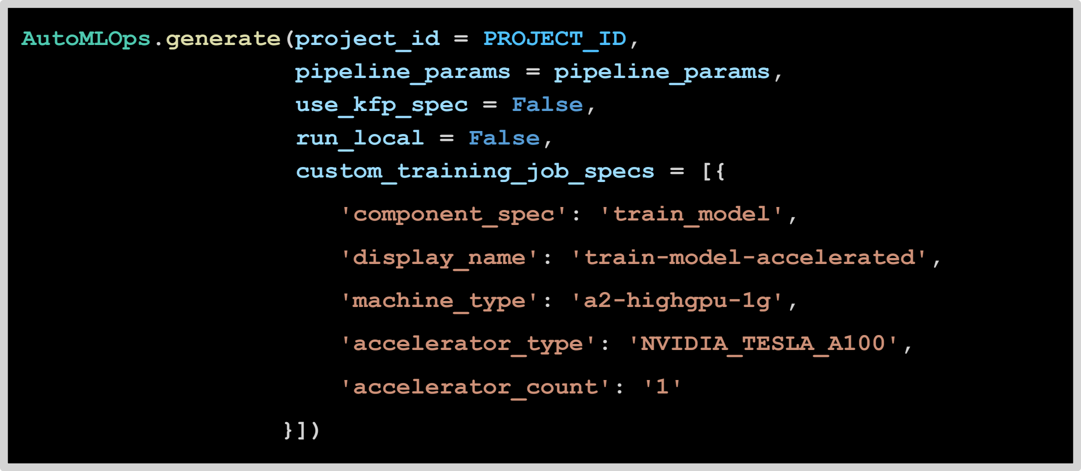
```
AutoMLOps.generate(project_id = PROJECT_ID,
                   pipeline_params = pipeline_params,
                   use_kfp_spec = False,
                   run_local = False,
                   schedule_pattern = '0 */12 * * *')
```

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'
                  }])
```

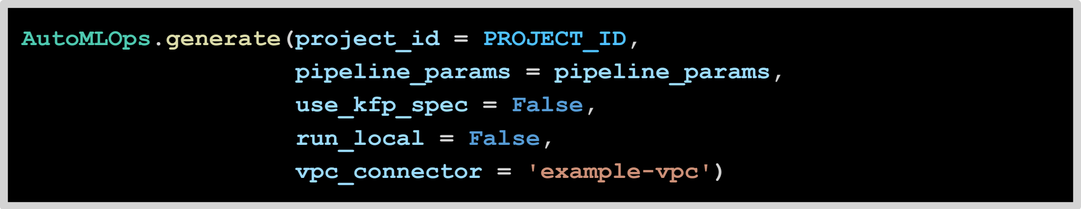
The example above uses a GPU for accelerated training. See Machine types and GPUs for more info.

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

Google Cloud

# 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