

```
In [1]: from azureml.core import Workspace, Experiment

ws = Workspace.from_config()
exp = Experiment(workspace=ws, name="udacity-project")

print('Workspace name: ' + ws.name,
      'Azure region: ' + ws.location,
      'Subscription id: ' + ws.subscription_id,
      'Resource group: ' + ws.resource_group, sep = '\n')

run = exp.start_logging()
```

Workspace name: quick-starts-ws-253892  
Azure region: eastus2  
Subscription id: 61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30  
Resource group: aml-quickstarts-253892

```
In [2]: from azureml.core.compute import ComputeTarget, AmlCompute

cluster_name = "proj-compute-cluster"

# TODO: Create compute cluster
# Use vm_size = "Standard_D2_V2" in your provisioning configuration.
# max_nodes should be no greater than 4.

try:
    cpu_cluster = ComputeTarget(workspace=ws, name=cluster_name)
    print('Cluster already created.')
except ComputeTargetException:
    compute_config = AmlCompute.provisioning_configuration(vm_size='STANDARD_D2_V2',
                                                         max_nodes=4)
    cpu_cluster = ComputeTarget.create(ws, cluster_name, compute_config)

cpu_cluster.wait_for_completion(show_output=True)
```

Cluster already created.  
Succeeded  
AmlCompute wait for completion finished

Minimum number of nodes requested have been provisioned

```
In [3]: from azureml.widgets import RunDetails
from azureml.train.sklearn import SKLearn
from azureml.train.hyperdrive.run import PrimaryMetricGoal
from azureml.train.hyperdrive.policy import BanditPolicy
from azureml.train.hyperdrive.sampling import RandomParameterSampling
from azureml.train.hyperdrive.runconfig import HyperDriveConfig
from azureml.train.hyperdrive.parameter_expressions import choice, uniform
from azureml.core import Environment, ScriptRunConfig
import os

# Specify parameter sampler
ps = RandomParameterSampling(
    {
        '--C': choice(0.01, 0.1, 0.5, 1),
        '--max_iter': choice(20, 40, 80, 120, 160, 200)
    }
)

# Specify a Policy
policy = BanditPolicy(evaluation_interval=2, slack_factor=0.1)

if "training" not in os.listdir():
    os.mkdir("./training")

# Setup environment for your training run
sklearn_env = Environment.from_conda_specification(name='sklearn-env', file_path=

# Create a ScriptRunConfig Object to specify the configuration details of your tr
src = ScriptRunConfig(source_directory="./training",
                      script='./train.py',
                      compute_target=cpu_cluster,
                      environment=sklearn_env)

# Create a HyperDriveConfig using the src object, hyperparameter sampler, and pol
hyperdrive_config = HyperDriveConfig(run_config=src,
                                     hyperparameter_sampling=ps,
                                     policy=policy,
                                     primary_metric_name='Accuracy',
                                     primary_metric_goal=PrimaryMetricGoal.MAXIMIZE,
                                     max_total_runs=20,
                                     max_concurrent_runs=4)
```

```
In [8]: # Submit your hyperdrive run to the experiment and show run details with the widg

#### YOUR CODE HERE ####
# run hyperdrive experiment
hyperdrive_run = exp.submit(config=hyperdrive_config)
```

In [9]:

# get run details  
RunDetails(hyperdrive\_run).show()

Non-numeric values for primary metric cannot be visualized in a 2D/3D/Parallel coordinates chart.

Run Properties

Status	Completed
Node run start time	2/23/2024 8:33:52 PM
Node run duration	0:16:08
Run Id	HD_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7
Max concurrent runs	4
Max total runs	20

Output Logs

azureml-logs/hyperdrive.txt

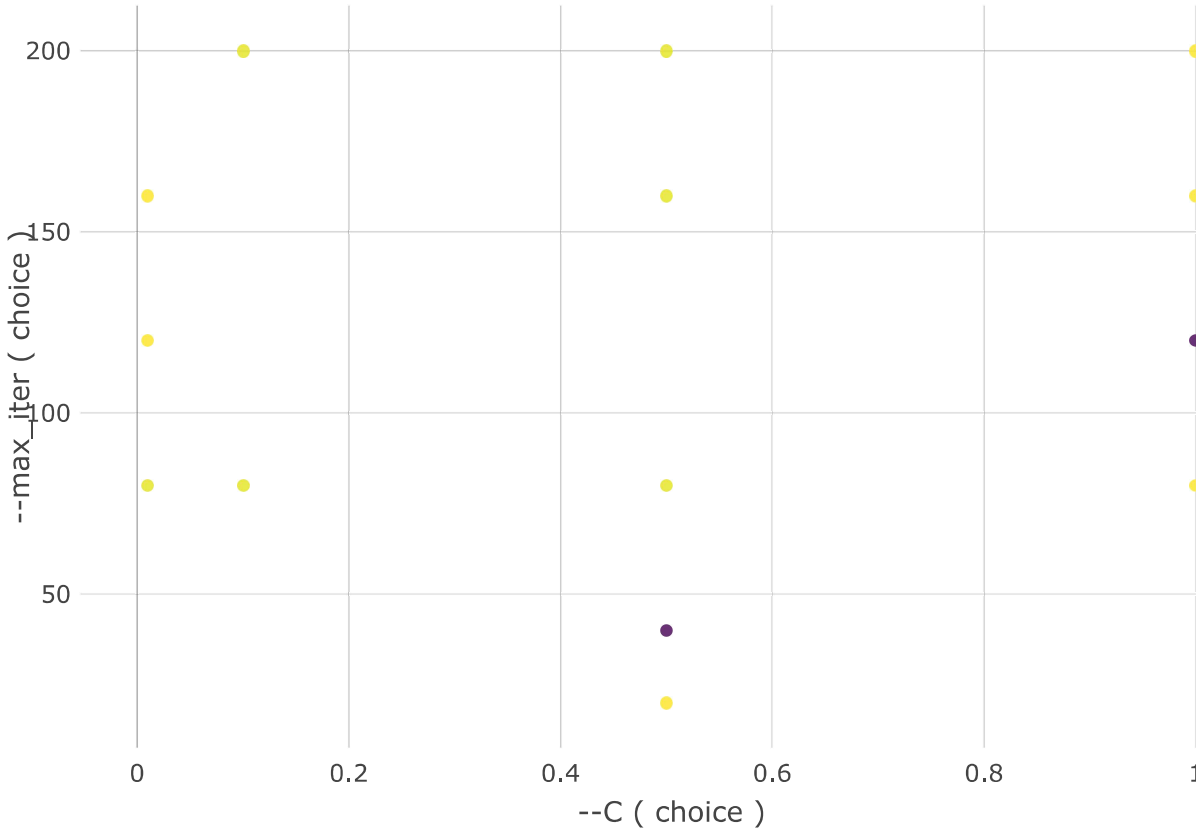
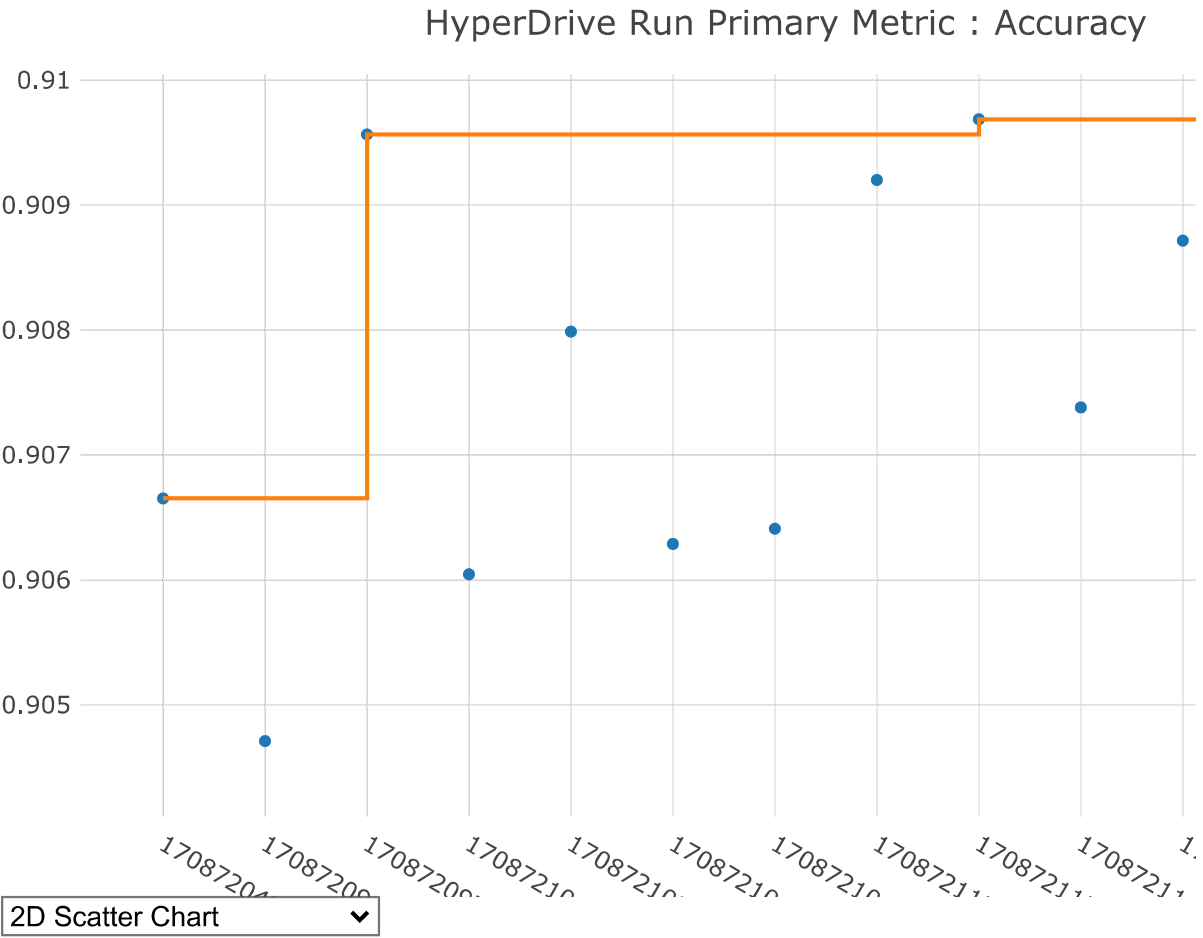
Show Active log

azureml-logs/hyperdrive.txt

[2024-02-23T20:47:54.187580][GENERATOR][INFO]Trying to sample '1' jobs from the hyperparameter space  
[2024-02-23T20:47:54.5716968Z][SCHEDULER][INFO]Scheduling job, id='HD\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7\_18'  
[2024-02-23T20:47:54.515024][GENERATOR][INFO]Successfully sampled '1' jobs, they will soon be submitted to the execution target.  
[2024-02-23T20:47:54.7927953Z][SCHEDULER][INFO]Successfully scheduled a job. Id='HD\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7\_18'  
[2024-02-23T20:48:24.174402][GENERATOR][INFO]Trying to sample '1' jobs from the hyperparameter space  
[2024-02-23T20:48:24.5906795Z][SCHEDULER][INFO]Scheduling job,

Run	Best Metric*	Status	Started	Duration
1708721154	0.90968682	Completed	Feb 23, 2024 8:46 PM	0:00:43
1708720974	0.90956543	Completed	Feb 23, 2024 8:43 PM	0:00:42
1708721124	0.90920126	Completed	Feb 23, 2024 8:45 PM	0:00:48
1708721244	0.9088371	Completed	Feb 23, 2024 8:47 PM	0:00:45
1708721214	0.90871571	Completed	Feb 23, 2024 8:47 PM	0:00:44

\* The best metric field is obtained from the min/max of primary metric achieved by a run



Click here to see the run in Azure Machine Learning studio

([https://ml.azure.com/runs/HD\\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?](https://ml.azure.com/runs/HD_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quickstarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254)

[wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quickstarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254\)](https://ml.azure.com/runs/HD_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quickstarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254)

```
In [33]: import joblib
# Get your best run and save the model from that run.
hyperdrive_run.wait_for_completion(show_output=True)
best_run = hyperdrive_run.get_best_run_by_primary_metric()
best_run_metrics = best_run.get_metrics()
parameter_values = best_run.get_details()
print('Best Run Id: ', best_run.id)
print('\n')
print('Best Run Metrics:', best_run_metrics)

model = best_run.register_model(model_name='hd-best', model_path='outputs/hd-best')
```

RunId: HD\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7

Web View: [https://ml.azure.com/runs/HD\\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254](https://ml.azure.com/runs/HD_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254) ([https://ml.azure.com/runs/HD\\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254](https://ml.azure.com/runs/HD_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254))

Execution Summary

=====

RunId: HD\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7

Web View: [https://ml.azure.com/runs/HD\\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254](https://ml.azure.com/runs/HD_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254) ([https://ml.azure.com/runs/HD\\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254](https://ml.azure.com/runs/HD_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7?wsid=/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resourcegroups/aml-quicksarts-253892/workspaces/quick-starts-ws-253892&tid=660b3398-b80e-49d2-bc5b-ac1dc93b5254))

Best Run Id: HD\_d72864b5-ebf1-42d4-9557-d8d0ca7d34e7\_13

Best Run Metrics: {'Max iterations:': 200, 'Regularization Strength:': 1.0, 'Accuracy': 0.909686817188638}

-----  
ModelPathNotFoundException

Traceback (most recent call last)

Cell In[33], line 11

```
8 print('\n')
9 print('Best Run Metrics:', best_run_metrics)
--> 11 model = best_run.register_model(model_name='hd-best', model_path='outputs/hd-best.joblib')
```

File /anaconda/envs/azureml\_py38/lib/python3.8/site-packages/azureml/core/run.py:2275, in Run.register\_model(self, model\_name, model\_path, tags, properties, model\_framework, model\_framework\_version, description, datasets, sample\_input\_dataset, sample\_output\_dataset, resource\_configuration, \*\*kwargs)

```
2235 """Register a model for operationalization.
```

```
2236
```

```
2237 .. remarks::
```

```
(...)
```

```
2272 :rtype: azureml.core.model.Model
```

```
2273 """
```

```
2274 model_name_validation(model_name)
```



```
In [17]: from azureml.data.dataset_factory import TabularDatasetFactory
from azureml.core import Dataset

# Create TabularDataset using TabularDatasetFactory
# Data is available at:
# "https://automlsamplenotebookdata.blob.core.windows.net/automl-sample-notebook-

### YOUR CODE HERE ###
url_path = 'https://automlsamplenotebookdata.blob.core.windows.net/automl-sample-
dataset = Dataset.Tabular.from_delimited_files(path=url_path)
azure_ml_df = dataset.to_pandas_dataframe()
print(azure_ml_df.head())
```

	age	job	marital	education	default	housing	loan	contact	\
0	57	technician	married	high.school	no	no	yes	cellular	
1	55	unknown	married	unknown	unknown	yes	no	telephone	
2	33	blue-collar	married	basic.9y	no	no	no	cellular	
3	36	admin.	married	high.school	no	no	no	telephone	
4	27	housemaid	married	high.school	no	yes	no	cellular	

	month	day_of_week	...	campaign	pdays	previous	poutcome	emp.var.rate
0	may	mon	...	1	999	1	failure	-1.8
1	may	thu	...	2	999	0	nonexistent	1.1
2	may	fri	...	1	999	1	failure	-1.8
3	jun	fri	...	4	999	0	nonexistent	1.4
4	jul	fri	...	2	999	0	nonexistent	1.4

	cons.price.idx	cons.conf.idx	euribor3m	nr.employed	y
0	92.893	-46.2	1.299	5099.1	no
1	93.994	-36.4	4.860	5191.0	no
2	92.893	-46.2	1.313	5099.1	no
3	94.465	-41.8	4.967	5228.1	no
4	93.918	-42.7	4.963	5228.1	no

[5 rows x 21 columns]

```
In [18]: from train import clean_data

# Use the clean_data function to clean your data.
x, y = clean_data(dataset)
ml_data = x.join(y)
```



```
In [19]: from azureml.train.automl import AutoMLConfig

# Set parameters for AutoMLConfig
# NOTE: DO NOT CHANGE THE experiment_timeout_minutes PARAMETER OR YOUR INSTANCE V
# If you wish to run the experiment longer, you will need to run this notebook in
# Azure tenant, which will incur personal costs.
automl_config = AutoMLConfig(
    experiment_timeout_minutes=30,
    task='classification',
    primary_metric='accuracy',
    training_data=ml_data,
    label_column_name='y',
    n_cross_validations=5,
    enable_early_stopping = True,
    enable_onnx_compatible_models = True
)
```

```
In [20]: # Submit your automl run
experiment = Experiment(ws, "automl_project_experiment")
run = experiment.submit(config=automl_config, show_output=True)

d')': /history/v1.0/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resour
ceGroups/aml-quickstarts-253892/providers/Microsoft.MachineLearningServices/w
orkspaces/quick-starts-ws-253892/experiments/udacity-project/runs/HD_d72864b5
-ebf1-42d4-9557-d8d0ca7d34e7
2024-02-23:21:33:09,661 WARNING [connectionpool.py:823] Retrying (Retry(tota
l=2, connect=2, read=3, redirect=None, status=None)) after connection broken
by 'NewConnectionError('<urllib3.connection.HTTPSConnection object at 0x7fc95
4a9d970>: Failed to establish a new connection: [Errno 111] Connection refuse
d')': /history/v1.0/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resour
ceGroups/aml-quickstarts-253892/providers/Microsoft.MachineLearningServices/w
orkspaces/quick-starts-ws-253892/experiments/udacity-project/runs/HD_d72864b5
-ebf1-42d4-9557-d8d0ca7d34e7/details
2024-02-23:21:33:13,237 WARNING [connectionpool.py:823] Retrying (Retry(tota
l=2, connect=2, read=3, redirect=None, status=None)) after connection broken
by 'NewConnectionError('<urllib3.connection.HTTPSConnection object at 0x7fc95
460f310>: Failed to establish a new connection: [Errno 111] Connection refuse
d')': /history/v1.0/subscriptions/61c5c3f0-6dc7-4ed9-a7f3-c704b20e3b30/resour
ceGroups/aml-quickstarts-253892/providers/Microsoft.MachineLearningServices/w
orkspaces/quick-starts-ws-253892/experiments/udacity-project/runs/HD_5ea420ef
```

```
In [25]: # Retrieve and save your best automl model.
from azureml.automl.runtime.onnx_convert import OnnxConverter

# getting best model and saving it out with onnx
automl_run, automl_best_model = run.get_output(return_onnx_model=True)

# convert and save the model
OnnxConverter.save_onnx_model(automl_best_model, file_path="./outputs/automl_best
```

```
In [ ]: # delete resources after use
AmlCompute.delete(cpu_cluster)
```

