Cloud Computing
Lab 4: Batch and Stream processing

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Objective:

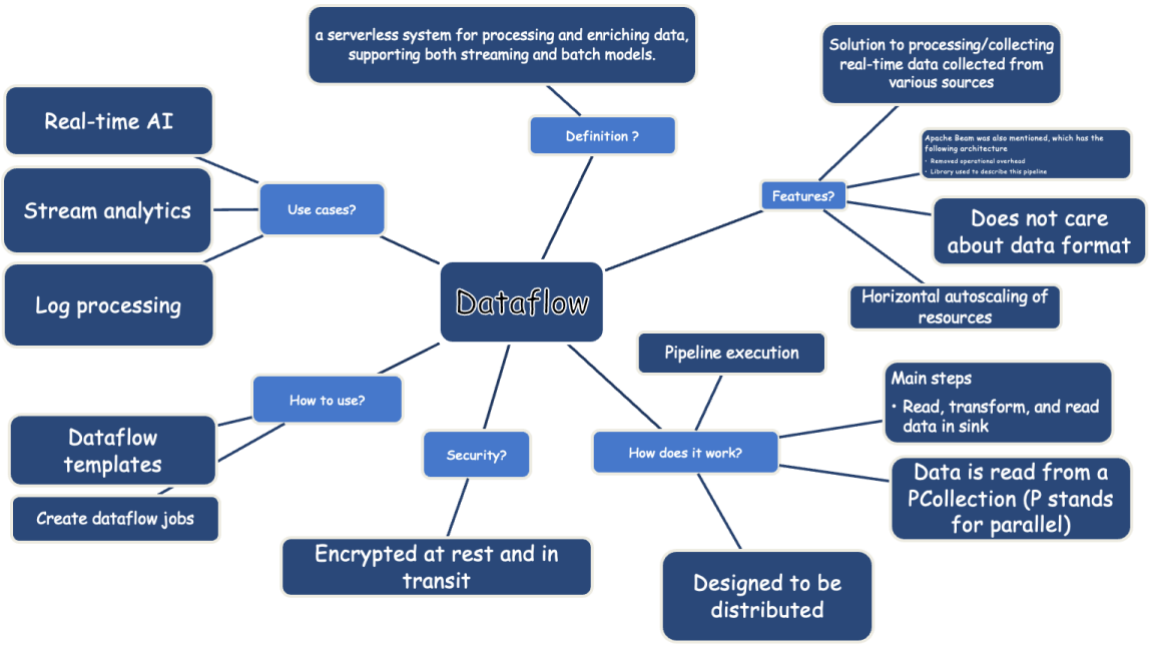
1. Get familiar with Dataflow
2. Understand MapReduce.
3. Run batch and Stream Processing examples over GCP.

Lab4 Repository: https://github.com/goergedaoud/SOFE4630U-tut4.git (Links to an external site.)

Procedure: There are 7 items/tasks given in Lab4. Answer all.

1 Q and A

Q: Watch the following video about Google Cloud Dataflow
A: Please see mindmap created below.



2 Q and A

Q: Watch the following video describing how to apply MapReduce to count the words within a certain document

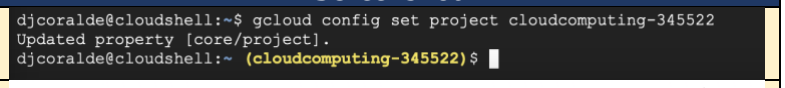
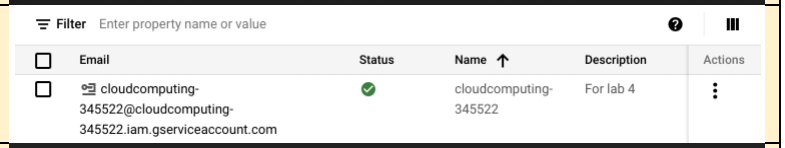
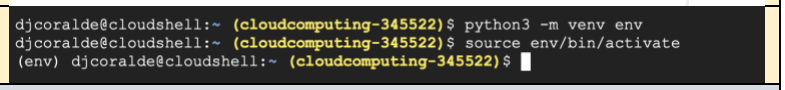
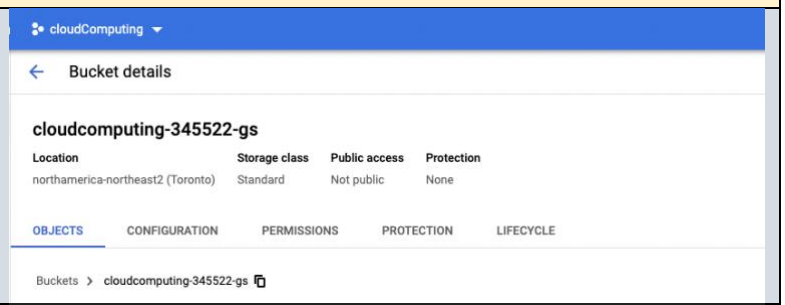
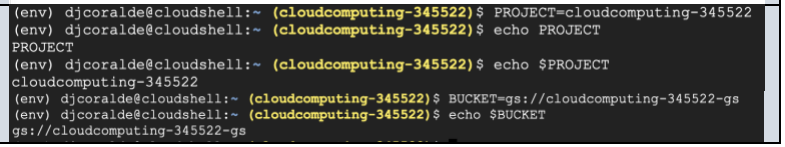
A: The second output added in wordcount2.py is the part which applies MapReduce.

3 Coding Exercise

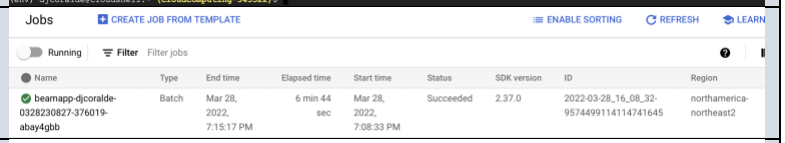
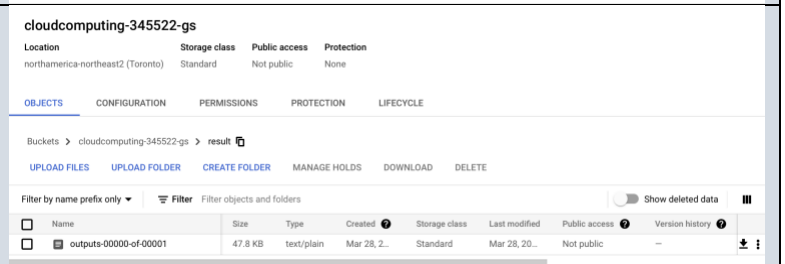
Follow the following video to set up the GCP environment for Dataflow and **run wordcount examples**.

3.1 Activity

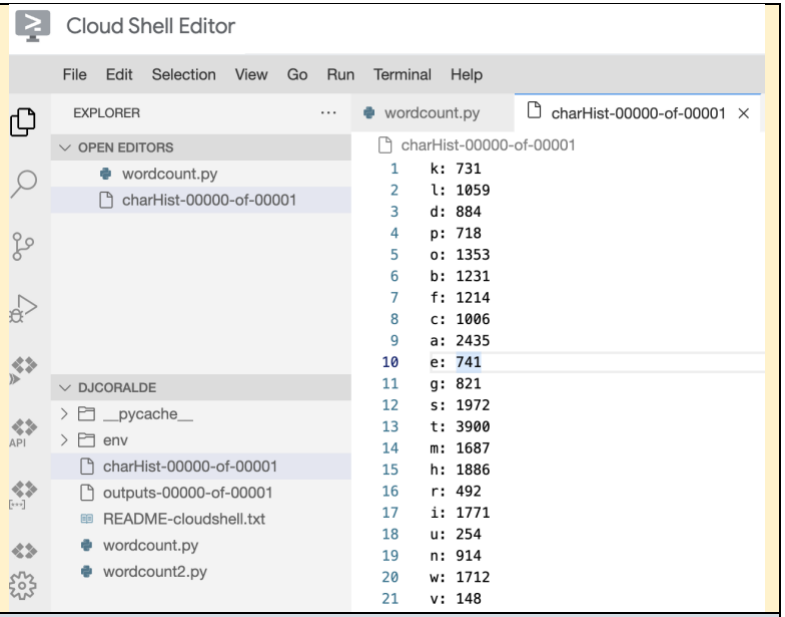
Following the given video, the table below shows a summary of actions/commands/screenshots to reflect all tasks in the video.

	Action	Command	Screenshot
Setup	Gloud config	`Gcloud config set project <name_of_project>`	
	Create services account		
	Activate venv	`Python3 -m venv env` `Source env/bin/activate`	
Install libraries	Upgrade pip	`pip install pip --upgrade`	
	Install apache-beam[gcp]	`pip install 'apache-beam[gcp]'`	
Run wordcount.py locally	Run code	`python -m apache_beam.examples.wordcount --output outputs`	
	View output file	`more outputs*`	
Run wordcount.py globally (over cloud)	Create cloud storage to be accessed (create storage bucket) To access storage bucket, use gs://<name_of_storage_bucket>		
	Set up PROJECT and BUCKET. These arguments will be used later when running the python script	`PROJECT = <name_of_project>` `BUCKET = gs://<link_to_bucket>`	

	Run	`python wordcount.py --region northamerica-northeast2 --runner DataflowRunner project $PROJECT --temp_location $BUCKET/tmp/ --output $BUCKET/result/outputs --experiment use_unsupported_python_version`	`(env) djcoralde@cloudshell:~ (cloudcomputing-345522)$ python -m apache_beam.examples.wordcount \`
			`> --project $PROJECT \`
			`> --region northamerica-northeast2 \`
			`> --runner dataflowRunner \`
			`> --temp_location $BUCKET/tmp \`
			`> --output $BUCKET/result/outputs`
			.. when finished
			`INFO:apache_beam.runners.dataflow.dataflow_runner:2022-03-28T23:12:22.364Z: JOB_MESSAGE_DETAILED: Cleaning up.`
			`INFO:apache_beam.runners.dataflow.dataflow_runner:2022-03-28T23:12:22.386Z: JOB_MESSAGE_DEBUG: Starting worker pool teardown.`
			`INFO:apache_beam.runners.dataflow.dataflow_runner:2022-03-28T23:12:22.394Z: JOB_MESSAGE_BASIC: Stopping worker pool...`
			`INFO:apache_beam.runners.dataflow.dataflow_runner:2022-03-28T23:14:42.702Z: JOB_MESSAGE_DETAILED: Autoscaling: Resized worker pool from 1 to 0.`
			`INFO:apache_beam.runners.dataflow.dataflow_runner:2022-03-28T23:14:42.720Z: JOB_MESSAGE_BASIC: Worker pool stopped.`
			`INFO:apache_beam.runners.dataflow.dataflow_runner:2022-03-28T23:14:42.733Z: JOB_MESSAGE_DEBUG: Tearing down pending resources...`
			`INFO:apache_beam.runners.dataflow.dataflow_runner:Job 2022-03-28_16_08_32-9574499114114741645 is in state JOB_STATE_DONE`
			`(env) djcoralde@cloudshell:~ (cloudcomputing-345522)$`

	View in dataflow		
	See in cloud storage		

	Run	`python -m wordcount2 --output outputs --output2 charHist`	`(env) djcoralde@cloudshell:~ (cloudcomputing-345522)$ ls`
			`charHist-00000-of-00001  outputs-00000-of-00001  README-cloudshell.txt  wordcount.py`
			`env                    __pycache__              wordcount2.py`

<table>
<tr>
<td>Run wordcount2.py locally</td>
<td>See in editor</td>
<td></td>
<td> 
</td>
</tr>
<tr>
<td rowspan="2">Run wordcount2.py over cloud</td>
<td>Set up arguments</td>
<td>PROJECT=$(gcloud config list project
--format "value(core.project)")
echo $PROJECT
BUCKET=gs://$PROJECT-gs
echo $BUCKET</td>
<td></td>
</tr>
<tr>
<td>Run</td>
<td>python wordcount2.py --region
northamerica-northeast2 --runner
DataflowRunner --project $PROJECT --
temp_location $BUCKET/tmp/ --input
gs://dataflow-
samples/shakespeare/winterstale.txt
--output $BUCKET/result/outputs --
output2 $BUCKET/result/outputs2 --
experiment
use_unsupported_python_version</td>
<td>  </td>
</tr>
</table>

4 Coding Exercise

Follow the following videos for various Dataflow examples for Batch and stream processing for the mnist dataset for various source and destination types; text file, MySQL database, and Kafka topics

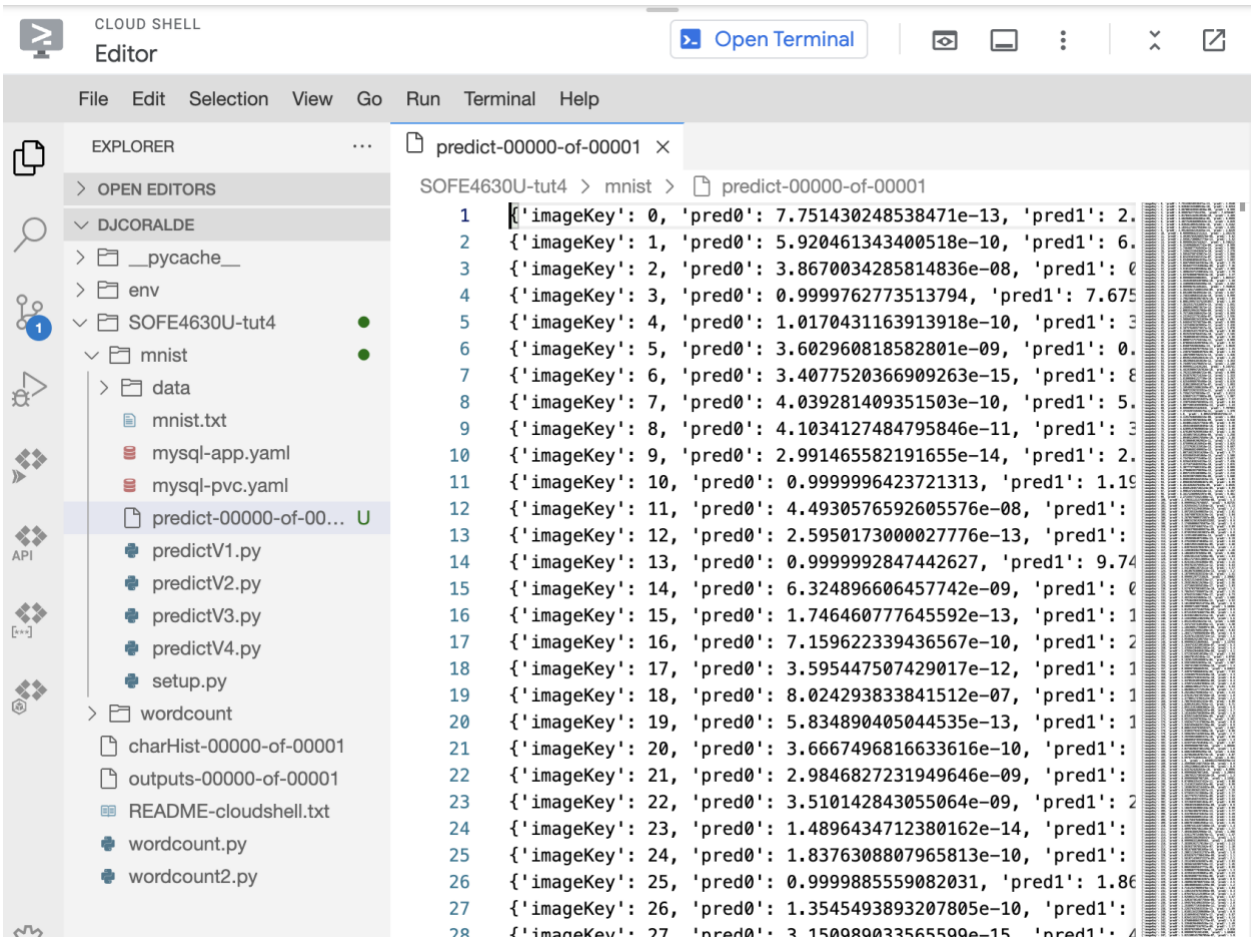
Mnist dataset are handwritten images.

```
Use "gcloud config set project [PROJECT_ID]" to change to a different project.
djcoralde@cloudshell:~ (cloudcomputing-345522)$ clear
djcoralde@cloudshell:~ (cloudcomputing-345522)$ cd ~
djcoralde@cloudshell:~ (cloudcomputing-345522)$ git clone https://github.com/goergedaoud/SOFE4630U-tut4.git
Cloning into 'SOFE4630U-tut4'...
remote: Enumerating objects: 122, done.
remote: Counting objects: 100% (122/122), done.
remote: Compressing objects: 100% (85/85), done.
remote: Total 122 (delta 58), reused 96 (delta 37), pack-reused 0
Receiving objects: 100% (122/122), 14.85 MiB | 14.70 MiB/s, done.
Resolving deltas: 100% (58/58), done.
djcoralde@cloudshell:~ (cloudcomputing-345522)$ cd ~/SOFE4630U-tut4/mnist
djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ source ~/env/bin/activate
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$
```

```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ pip install tensorflow-cpu==2.8.0
Collecting tensorflow-cpu==2.8.0
  Downloading tensorflow_cpu-2.8.0-cp39-cp39-manylinux2010_x86_64.whl (190.6 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 190.6/190.6 MB 4.9 MB/s eta 0:00:00
  Running setup.py install for termcolor ... done
Successfully installed absl-py-1.0.0 astunparse-1.6.3 flatbuffers-2.0 gast-0.5.3 google-auth-oauthlib-0.4.6 goo
gle-pasta-0.2.0 h5py-3.6.0 importlib-metadata-4.11.3 keras-2.8.0 keras-preprocessing-1.1.2 libclang-13.0.0 mark
down-3.3.6 oauthlib-3.2.0 opt-einsum-3.3.0 requests-oauthlib-1.3.1 tensorboard-2.8.0 tensorboard-data-server-0.
6.1 tensorboard-plugin-wit-1.8.1 tensorflow-cpu-2.8.0 tensorflow-io-gcs-filesystem-0.24.0 termcolor-1.1.0 tf-es
timator-nightly-2.8.0.dev2021122109 werkzeug-2.1.0 wheel-0.37.1 zipp-3.7.0
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$
```

Run python script locally, see local output file in cloud editor

```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ python ./predictV1.py \
    --staging_location ./staging \
    --temp_location ./temp \
    --model ./data \
    --source text \
        --setup_file ./setup.py \
    --input ./data/images.txt \
    --output ./predict
```



Set up $PROJECT and $BUCKET

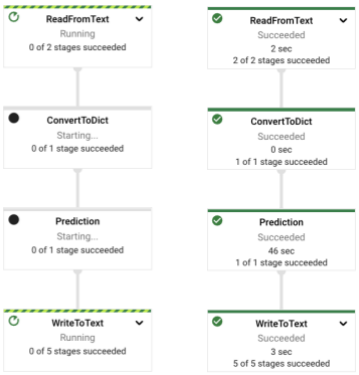
```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ PROJECT=$(gcloud config list project
 --format "value(core.project)")
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ echo $PROJECT
cloudcomputing-345522
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ BUCKET=gs://$PROJECT-gs
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ echo $BUCKET
gs://cloudcomputing-345522-gs
```

Copy files from data to cloud storage

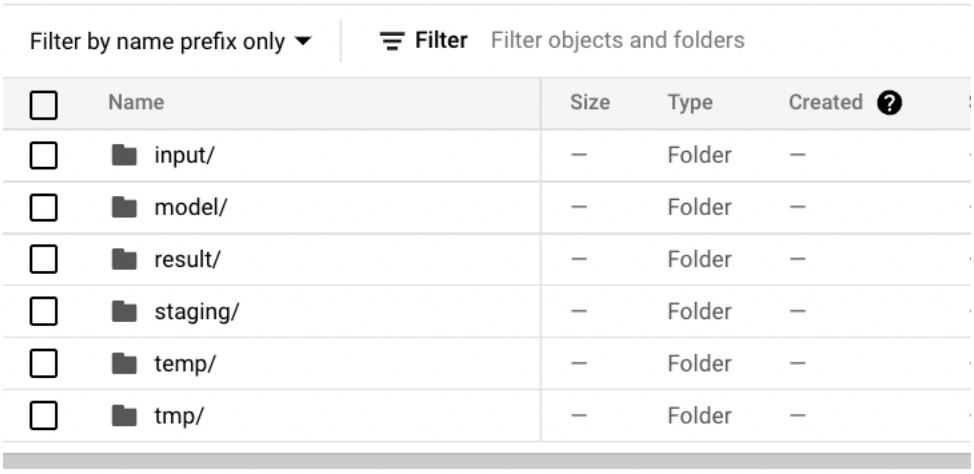
```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ gsutil cp data/export* $BUCKET/model
/
Copying file://data/export.data-00000-of-00001 [Content-Type=application/octet-stream]...
Copying file://data/export.index [Content-Type=application/octet-stream]...
Copying file://data/export.meta [Content-Type=application/octet-stream]...
- [3 files][ 12.5 MiB/ 12.5 MiB]
Operation completed over 3 objects/12.5 MiB.
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ gsutil cp data/images.txt $BUCKET/in
put/
Copying file://data/images.txt [Content-Type=text/plain]...
- [1 files][ 45.2 MiB/ 45.2 MiB]
Operation completed over 1 objects/45.2 MiB.
```

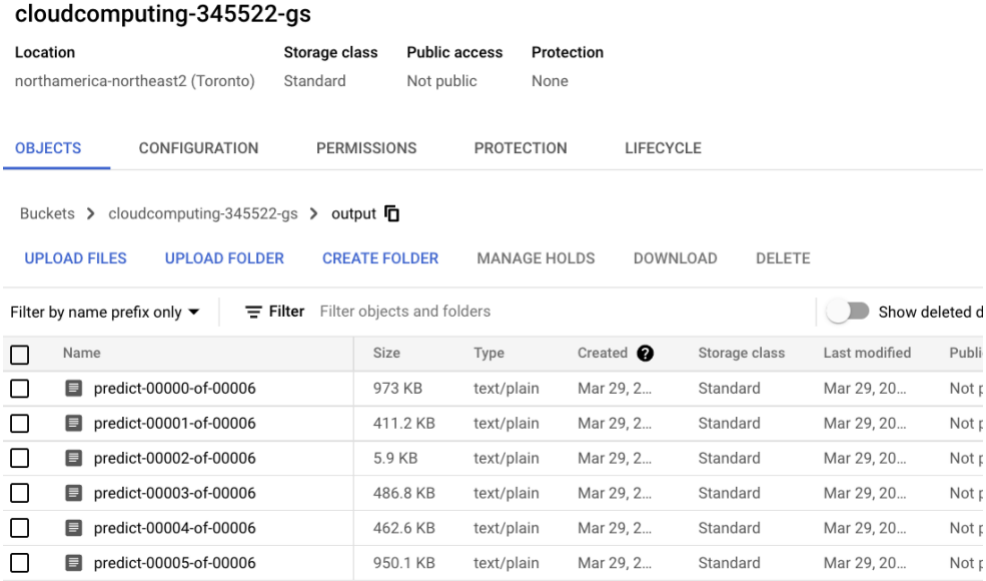
Run code over cloud

- See job in dataflow>jobs



- See created files in cloud storage



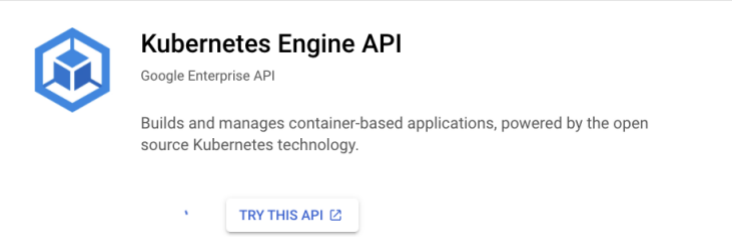


Install beam nuggets locally

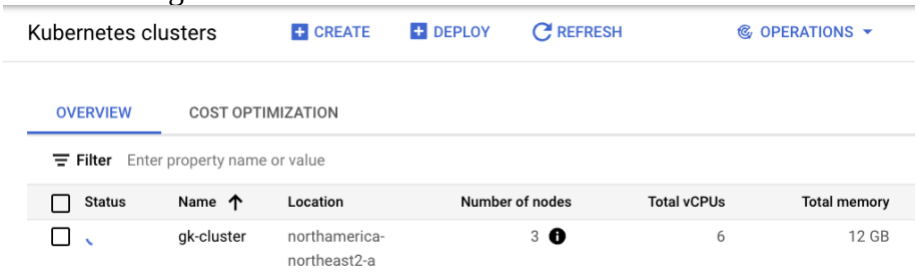
```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ pip install beam-nuggets
Collecting beam-nuggets
  Downloading beam_nuggets-0.18.1-py3-none-any.whl (25 kB)
Requirement already satisfied: apache-beam<3.0.0,>=2.8.0 in /home/djcoralde/env/lib/python3.9/site-packages (from beam-nuggets) (2.37.0)
```

Set up Kubernetes Engine

- Enable



- Create cluster using commands



- Gcloud commands

```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ gcloud container clusters create gk-cluster --num-nodes=3
Default change: VPC-native is the default mode during cluster creation for versions greater than 1.21.0-gke.1500. To create advanced routes based c
lusters, please pass the `--no-enable-ip-alias` flag
Note: Your Pod address range (`--cluster-ipv4-cidr`) can accommodate at most 1008 node(s).
Creating cluster gk-cluster in northamerica-northeast2-a... Cluster is being deployed...working..
Creating cluster gk-cluster in northamerica-northeast2-a... Cluster is being health-checked (master is heal
thy)...done.
Created [https://container.googleapis.com/v1/projects/cloudcomputing-345522/zones/northamerica-northeast2-a/clusters/gk-cluster].
To inspect the contents of your cluster, go to: https://console.cloud.google.com/kubernetes/workload_/gcloud/northamerica-northeast2-a/gk-cluster?p
roject=cloudcomputing-345522
kubeconfig entry generated for gk-cluster.
NAME: gk-cluster
LOCATION: northamerica-northeast2-a
MASTER_VERSION: 1.21.9-gke.1002
MASTER_IP: 34.130.78.96
MACHINE_TYPE: e2-medium
NODE_VERSION: 1.21.9-gke.1002
NUM_NODES: 3
STATUS: RUNNING
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ gcloud container clusters get-credentials gk-cluster
Fetching cluster endpoint and auth data.
kubeconfig entry generated for gk-cluster.
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$
```

Wait until external IP for mysql has value instead of pending.

```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ kubectl get services
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP    PORT(S)          AGE
kubernetes   ClusterIP      10.112.0.1      <none>         443/TCP          3m25s
mysql        LoadBalancer   10.112.14.148   <pending>      3306:30172/TCP   10s
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ kubectl get services
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP    PORT(S)          AGE
kubernetes   ClusterIP      10.112.0.1      <none>         443/TCP          3m50s
mysql        LoadBalancer   10.112.14.148   <pending>      3306:30172/TCP   35s
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ kubectl get services
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP     PORT(S)          AGE
kubernetes   ClusterIP      10.112.0.1      <none>          443/TCP          4m17s
mysql        LoadBalancer   10.112.14.148   34.130.125.8    3306:30172/TCP   62s
```

Set up $MYSQLIP

```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ MYSQLIP=$(kubectl get services mysql -o jsonpath='{.status.loadBalancer.
ingress[0].ip}')
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ echo $MYSQLIP
34.130.125.8
```

MySQL commands

```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ mysql -uuser -pSOFE4630U  -h$MYSQLIP <./data/images.sql
mysql: [Warning] Using a password on the command line interface can be insecure.
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ mysql -uuser -pSOFE4630U  -h$MYSQLIP <<<"use myDB; show tables;"
mysql: [Warning] Using a password on the command line interface can be insecure.
Tables_in_myDB
images
result
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ mysql -uuser -pSOFE4630U  -h$MYSQLIP <<<"select * from myDB.results;"
mysql: [Warning] Using a password on the command line interface can be insecure.
imageKey        pred0   pred1   pred2   pred3   pred4   pred5   pred6   pred7   pred8   pred9
1       0.000000000592046       0.000000068255  1       0.00000000176039        0.00000000000133647     0.0000000000000195916   0.0000000161139 0.00000000000000454879      0.00000000274564        9.56089e
-18
2       0.00000003867   0.999933        0.00000286329   0.0000000225886 0.000033936     0.0000000357466 0.000000254496  0.0000260632    0.00000340511       0.0000000244109
3       0.999976        0.00000000000767564     0.000000496665  0.000000000296386       0.000000000398382       0.0000000096914 0.0000231924    0.00000000490636    0.000000000416177       0.00000000590102
4       0.000000000101704       0.00000000348997        0.0000000035179 0.00000000000370033     0.999948        0.0000000000158648      0.00000000238752    0.00000124147   0.0000000000535041      0.000050
4937
5       0.00000000360296        0.999957        0.00000000877378 0.000000000724612       0.00000207376   0.000000000246704       0.0000000019372 0.0000401187        0.000000276865  0.00000000380118
6       0.0000000000000340775   0.0000000802971 0.00000000188454        0.0000000000310247      0.999982        0.0000000000372675      0.000000000132338   0.00000376211   0.0000105578    0.00000314445
7       0.000000000403928       0.00000053162   0.00000072458   0.000068992     0.00613112      0.000000610434  0.0000000123234         0.0000213121        0.0000792434    0.993691
8       0.0000000000410341      0.0000000000359552      0.0000000464476 0.0000000013431 0.0000000445756 0.994047        0.000648605     0.0000000652861     0.00530346      0.0000000645517
9       0.0000000000000299147   0.0000000000000202292   0.0000000000230089      0.000000000734767       0.00000434137   0.00000000192511        1.22969e-17         0.0000158272    0.0000000823186 0.99998
10      1       0.000000000000119218    0.000000400777  0.0000000000000722985   4.78715e-16     0.00000000000255285     0.00000000454809        0.00000000000109392         0.00000000000822686     0.000000
00287147
11      0.0000000449306 0.00000000000902127     0.000000000685528       0.000000000000116602    0.00000000221475        0.000000000233156       0.999999    5.17569e-16     0.00000107018   0.00000000000004
```

Run over cloud

- Command

```
(env) djcoralde@cloudshell:~/SOFE4630U-tut4/mnist (cloudcomputing-345522)$ python ./predictV2.py \
    --runner DataflowRunner \
    --project $PROJECT \
    --staging_location $BUCKET/staging \
    --temp_location $BUCKET/temp \
    --model $BUCKET/model \
    --source mysql \
        --setup_file ./setup.py \
        --input $MYSQLIP \
    --output $MYSQLIP \
        --region  northamerica-northeast2 \
     --experiment use_unsupported_python_version
```

- See DataFlow>Jobs (**got stuck here**)

5 (optional)

Q: The following video describes how to use BigQuery and Google PubSub as sources and destinations for the Dataflow pipeline

6 Q and A

Q: Google Cloud has another processing service called DataProc. Name another processing service that is usually used in the cloud environment (not necessarily GCP). Compare between it and both Dataflow and DataProc. Your comparison may include but is not limited to the major differences, advantages, disadvantages, and limitations.

A: DataProc enables users to take advantage of open source tools for batch processing, querying, streaming, and machine learning [https://cloud.google.com/dataproc/docs/concepts/overview] To compare with DataProc and DataFlow, chose **DataPrep**. Below, is a table comparing the three.

	DataProc	DataFlow	DataPrep
System Integration	Apache Spark and Hadoop	Apache Beam	BigTable and BigQuery
Ease of Use	Simple, easy to use	Relatively difficult	Easy to use
Provisioning	Provisioning clusters is done manually	Serverless, automatic	Fully automated
Approach	Hands-on, dev-ops	Fully managed, no-ops	Fully managed, no-ops
Unique For	Data science/ ML ecosystem	Batch and stream processing	UI driven processing

7 Q and A

Q: Suggest a practical application using both stream and batch processing that can be applied to a given dataset.

It's expected to use the dataset uploaded in the third milestone but you can use any other dataset. If you decided to use another dataset, It should maintain both variety and huge volume. Your report should include but not limited to

- The application.
- Its impact.
- The used dataset (size, schema/structure).
- A graph showing the proposed pipeline(s).
- List of other tools (AI, clustering,…) needed to implement that application.

A: ---