1. Create a cluster on GKE
   gcloud container clusters create spark --num-nodes=1 --machine-type=e2-highmem-2 --region=us-west1

```
NAME   LOCATION   MASTER_VERSION    MASTER_IP     MACHINE_TYPE   NODE_VERSION      NUM_NODES  STATUS
spark  us-west1   1.18.16-gke.502   35.230.50.43  e2-highmem-2   1.18.16-gke.502   3          RUNNING
```

2. Install NFS server provisioner
   helm repo add stable https://charts.helm.sh/stable

```
montaos19518@cloudshell:~ (cs571-306821)$ helm repo add stable https://charts.helm.sh/stable
"stable" has been added to your repositories
```

   helm install nfs stable/nfs-server-provisioner \
   --set persistence.enabled=true,persistence.size=5Gi

```
montaos19518@cloudshell:~ (cs571-new)$ helm install nfs stable/nfs-server-provisioner \
> --set persistence.enabled=true,persistence.size=5Gi

WARNING: This chart is deprecated
NAME: nfs
LAST DEPLOYED: Thu Apr 22 17:53:27 2021
NAMESPACE: default
STATUS: deployed
REVISION: 1
TEST SUITE: None
NOTES:
The NFS Provisioner service has now been installed.

A storage class named 'nfs' has now been created
and is available to provision dynamic volumes.

You can use this storageclass by creating a `PersistentVolumeClaim` with the
correct storageClassName attribute. For example:

    ---
    kind: PersistentVolumeClaim
    apiVersion: v1
    metadata:
      name: test-dynamic-volume-claim
    spec:
      storageClassName: "nfs"
      accessModes:
        - ReadWriteOnce
      resources:
        requests:
          storage: 100Mi
```

3. Create a persistent disk volume and a pod to use NFS

```
montaos19518@cloudshell:~ (cs571-new)$ cat spark-pvc.yaml
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
    name: spark-data-pvc
spec:
    accessModes:
        - ReadWriteMany
    resources:
        requests:
            storage: 2Gi
    storageClassName: nfs
---
apiVersion: v1
kind: Pod
metadata:
    name: spark-data-pod
spec:
    volumes:
        - name: spark-data-pv
          persistentVolumeClaim:
            claimName: spark-data-pvc
    containers:
        - name: inspector
          image: bitnami/minideb
          command:
            - sleep
            - infinity
          volumeMounts:
            - mountPath: "/data"
              name: spark-data-pv
```

4. Apply the YAML descriptor

   `kubectl apply -f spark-pvc.yaml`

```
montaos19518@cloudshell:~ (cs571-new)$ kubectl apply -f spark-pvc.yaml
persistentvolumeclaim/spark-data-pvc created
pod/spark-data-pod created
```

5. Create and prepare the app JAR file

   `docker run -v /tmp:/tmp -it bitnami/spark -- find /opt/bitnami/spark/examples/jars/ -name spark-examples* -exec cp {} /tmp/my.jar \;`

```
montaos19518@cloudshell:~ (cs571-new)$ docker run -v /tmp:/tmp -it bitnami/spark -- find /opt/bitnami/spark/examples/jars/ -name spark-examples* -exec cp {} /tmp/my.jar \;
Unable to find image 'bitnami/spark:latest' locally
latest: Pulling from bitnami/spark
f87be781ad7c: Pull complete
08a308c29bf9: Pull complete
0595528da3a0: Pull complete
a895f572d643: Pull complete
f1a363eccc8d: Pull complete
d833c8086411: Pull complete
65def5cdfce9: Pull complete
0c6b4e1e73e7: Pull complete
29e6a48f7b02: Pull complete
8693a54dced2: Pull complete
Digest: sha256:f5ea4708250bcc4cb6b97f9e7978c1f40bb1402108b5c9a80781bc97fc7d233d
Status: Downloaded newer image for bitnami/spark:latest
 17:59:37.15
 17:59:37.16 Welcome to the Bitnami spark container
 17:59:37.16 Subscribe to project updates by watching https://github.com/bitnami/bitnami-docker-spark
 17:59:37.16 Submit issues and feature requests at https://github.com/bitnami/bitnami-docker-spark/issues
 17:59:37.16
```

6. Add a test file with multiple line of words for the word count
   ```
   echo "Having knowledge but lacking the power to express it clearly is no
   better than never having any ideas at all" > /tmp/test.txt
   ```

7. Copy the JAR file containing the application and other required files to the PVC using a mount point
   ```
   kubectl cp /tmp/my.jar spark-data-pod:/data/my.jar
   kubectl cp /tmp/test.txt spark-data-pod:/data/test.txt
   ```

8. Make sure the files are in the persistent volume (PV)
   ```
   kubectl exec -it spark-data-pod -- ls -al /data
   ```
   ```
   montaos19518@cloudshell:~ (cs571-new)$ kubectl exec -it spark-data-pod -- ls -al /data
   total 1504
   drwxrwsrwx 2 root root    4096 Apr 22 18:00 .
   drwxr-xr-x 1 root root    4096 Apr 22 17:58 ..
   -rw-r--r-- 1 1001 root 1527168 Apr 22 18:00 my.jar
   -rw-r--r-- 1 1000 1001     109 Apr 22 18:00 test.txt
   ```

9. Deploy Apache Spark on Kubernetes using the shared volume
   ```
   montaos19518@cloudshell:~ (cs571-new)$ cat spark-chart.yaml
   service:
       type: LoadBalancer
   worker:
       replicaCount: 3
       extraVolumes:
           - name: spark-data
             persistentVolumeClaim:
               claimName: spark-data-pvc
       extraVolumeMounts:
           - name: spark-data
             mountPath: /data
   ```

10. Deploy Apache Spark using Bitnami Apache Spark Helm Chart and supply it with the configuration YAML file
    ```
    helm repo add bitnami https://charts.bitnami.com/bitnami
    ```
    ```
    montaos19518@cloudshell:~ (cs571-306821)$ helm repo add bitnami https://charts.bitnami.com/bitnami
    "bitnami" has been added to your repositories
    ```

```
helm install spark bitnami/spark -f spark-chart.yaml
```

```
montaos19518@cloudshell:~ (cs571-new)$ helm install spark bitnami/spark -f spark-chart.yaml
NAME: spark
LAST DEPLOYED: Thu Apr 22 18:04:21 2021
NAMESPACE: default
STATUS: deployed
REVISION: 1
TEST SUITE: None
NOTES:
1. Get the Spark master WebUI URL by running these commands:

    NOTE: It may take a few minutes for the LoadBalancer IP to be available.
    You can watch the status of by running 'kubectl get --namespace default svc -w spark-master-svc'

  export SERVICE_IP=$(kubectl get --namespace default svc spark-master-svc -o jsonpath="{.status.loadBalancer.ingress[0]['ip', 'hostname'] }")
  echo http://$SERVICE_IP:80

2. Submit an application to the cluster:

  To submit an application to the cluster the spark-submit script must be used. That script can be
  obtained at https://github.com/apache/spark/tree/master/bin. Also you can use kubectl run.

  Run the commands below to obtain the master IP and submit your application.

  export EXAMPLE_JAR=$(kubectl exec -ti --namespace default spark-worker-0 -- find examples/jars/ -name 'spark-example*\.jar' | tr -d '\r')
  export SUBMIT_IP=$(kubectl get --namespace default svc spark-master-svc -o jsonpath="{.status.loadBalancer.ingress[0]['ip', 'hostname'] }")

  kubectl run --namespace default spark-client --rm --tty -i --restart='Never' \
    --image docker.io/bitnami/spark:3.1.1-debian-10-r42 \
    -- spark-submit --master spark://$SUBMIT_IP:7077 \
    --deploy-mode cluster \
    --class org.apache.spark.examples.SparkPi \
    $EXAMPLE_JAR 1000

** IMPORTANT: When submit an application the --master parameter should be set to the service IP, if not, the application will not resolve the master. **

** Please be patient while the chart is being deployed **
```

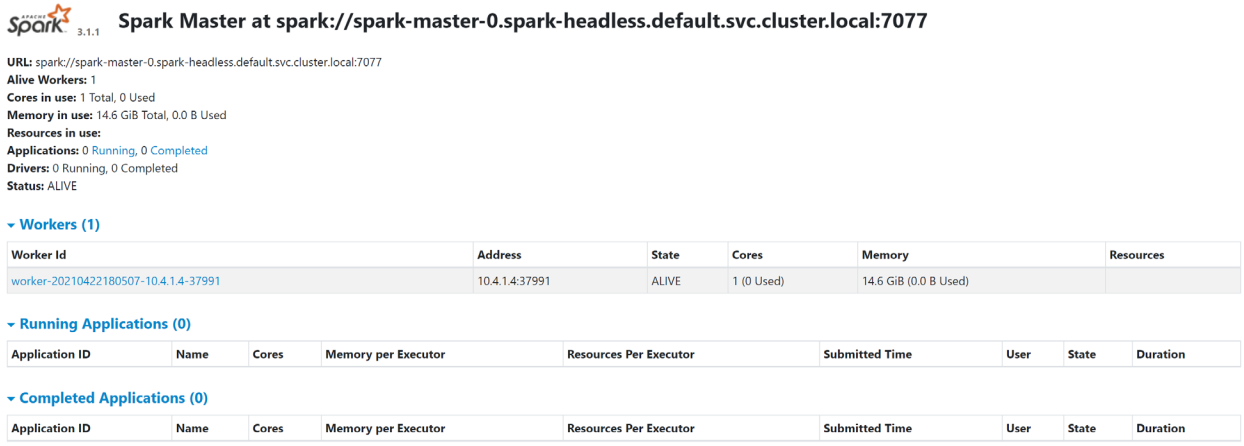
11. Get the external IP of the running pod

    ```
    kubectl get svc -l
    "app.kubernetes.io/instance=spark,app.kubernetes.io/name=spark"
    ```

```
montaos19518@cloudshell:~ (cs571-new)$ kubectl get svc -l "app.kubernetes.io/instance=spark,app.kubernetes.io/name=spark"
NAME               TYPE           CLUSTER-IP    EXTERNAL-IP    PORT(S)                       AGE
spark-headless     ClusterIP      None          <none>         <none>                        43s
spark-master-svc   LoadBalancer   10.7.250.8    34.83.40.52    7077:32236/TCP,80:30207/TCP   43s
```

12. Use your browser to open the external IP

    ```
    http://<external IP>
    ```

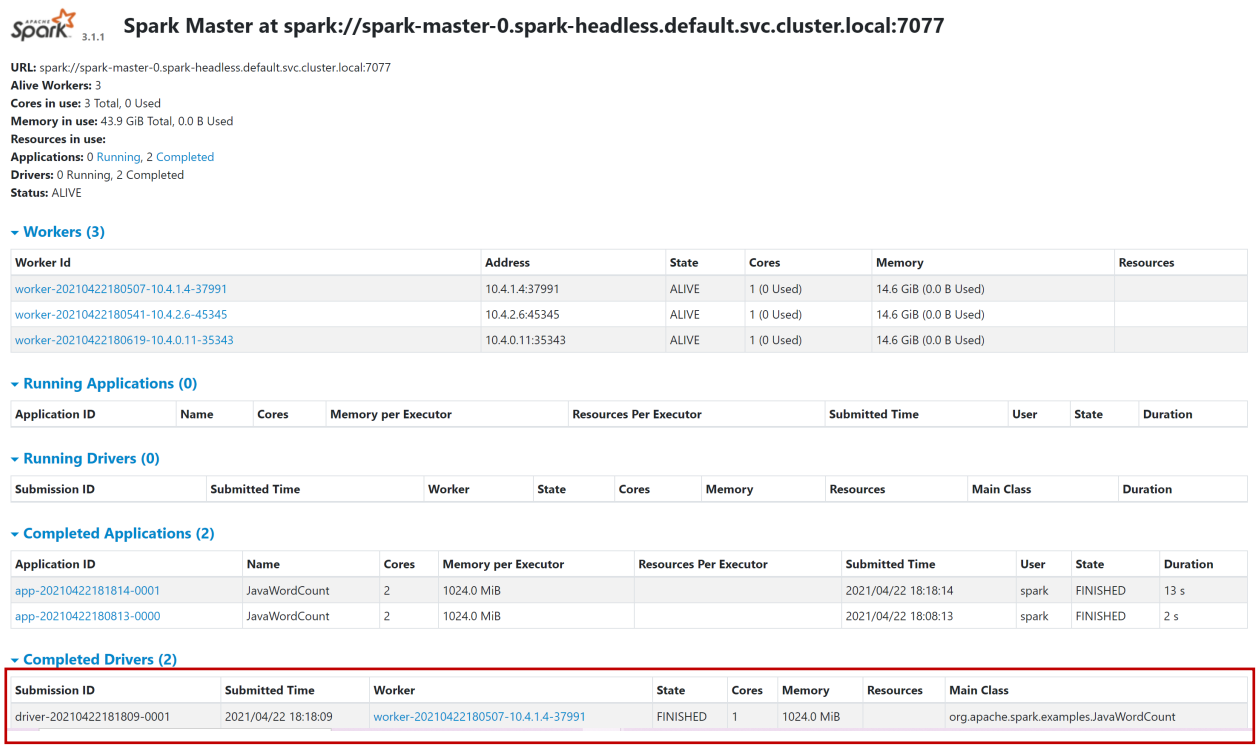



13. Submit a word count task

    ```
    kubectl run --namespace default spark-client --rm --tty -i --restart='Never' \
    --image docker.io/bitnami/spark:3.0.1-debian-10-r115 \
    -- spark-submit --master spark://<external IP>:7077 \
    --deploy-mode cluster \
    --class org.apache.spark.examples.JavaWordCount \
    /data/my.jar /data/text.txt
    ```

```
montaos19518@cloudshell:~ (cs571-new)$ kubectl run --namespace default spark-client --rm --tty -i --restart='Never' \
> --image docker.io/bitnami/spark:3.0.1-debian-10-r115 \
> -- spark-submit --master spark://34.83.40.52:7077 \
> --deploy-mode cluster \
> --class org.apache.spark.examples.JavaWordCount \
> /data/my.jar /data/text.txt
If you don't see a command prompt, try pressing enter.
log4j:WARN No appenders could be found for logger (org.apache.hadoop.util.NativeCodeLoader).
log4j:WARN Please initialize the log4j system properly.
log4j:WARN See http://logging.apache.org/log4j/1.2/faq.html#noconfig for more info.
Using Spark's default log4j profile: org/apache/spark/log4j-defaults.properties
21/04/22 18:08:07 INFO SecurityManager: Changing view acls to: spark
21/04/22 18:08:07 INFO SecurityManager: Changing modify acls to: spark
21/04/22 18:08:07 INFO SecurityManager: Changing view acls groups to:
21/04/22 18:08:07 INFO SecurityManager: Changing modify acls groups to:
21/04/22 18:08:07 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users  with view permissions: Set(spark); groups with view permissions: Set(); users  wit
h modify permissions: Set(spark); groups with modify permissions: Set()
21/04/22 18:08:07 INFO Utils: Successfully started service 'driverClient' on port 44277.
21/04/22 18:08:07 INFO TransportClientFactory: Successfully created connection to /34.83.40.52:7077 after 64 ms (0 ms spent in bootstraps)
21/04/22 18:08:08 INFO ClientEndpoint: Driver successfully submitted as driver-20210422180808-0000
21/04/22 18:08:08 INFO ClientEndpoint: ... waiting before polling master for driver state
21/04/22 18:08:13 INFO ClientEndpoint: ... polling master for driver state
21/04/22 18:08:13 INFO ClientEndpoint: State of driver-20210422180808-0000 is RUNNING
21/04/22 18:08:13 INFO ClientEndpoint: Driver running on 10.4.2.6:45345 (worker-20210422180541-10.4.2.6-45345)
21/04/22 18:08:13 INFO ShutdownHookManager: Shutdown hook called
21/04/22 18:08:13 INFO ShutdownHookManager: Deleting directory /tmp/spark-e129043c-ecd2-46cb-95ce-a9aabe4b7f70
pod "spark-client" deleted
```

14. Refresh the browser to see the completed task



Spark 3.1.1

## Spark Master at spark://spark-master-0.spark-headless.default.svc.cluster.local:7077

**URL:** spark://spark-master-0.spark-headless.default.svc.cluster.local:7077
**Alive Workers:** 3
**Cores in use:** 3 Total, 0 Used
**Memory in use:** 43.9 GiB Total, 0.0 B Used
**Resources in use:**
**Applications:** 0 Running, 2 Completed
**Drivers:** 0 Running, 2 Completed
**Status:** ALIVE

### Workers (3)

| Worker Id | Address | State | Cores | Memory | Resources |
|---|---|---|---|---|---|
| worker-20210422180507-10.4.1.4-37991 | 10.4.1.4:37991 | ALIVE | 1 (0 Used) | 14.6 GiB (0.0 B Used) | |
| worker-20210422180541-10.4.2.6-45345 | 10.4.2.6:45345 | ALIVE | 1 (0 Used) | 14.6 GiB (0.0 B Used) | |
| worker-20210422180619-10.4.0.11-35343 | 10.4.0.11:35343 | ALIVE | 1 (0 Used) | 14.6 GiB (0.0 B Used) | |

### Running Applications (0)

| Application ID | Name | Cores | Memory per Executor | Resources Per Executor | Submitted Time | User | State | Duration |
|---|---|---|---|---|---|---|---|---|

### Running Drivers (0)

| Submission ID | Submitted Time | Worker | State | Cores | Memory | Resources | Main Class | Duration |
|---|---|---|---|---|---|---|---|---|

### Completed Applications (2)

| Application ID | Name | Cores | Memory per Executor | Resources Per Executor | Submitted Time | User | State | Duration |
|---|---|---|---|---|---|---|---|---|
| app-20210422181814-0001 | JavaWordCount | 2 | 1024.0 MiB | | 2021/04/22 18:18:14 | spark | FINISHED | 13 s |
| app-20210422180813-0000 | JavaWordCount | 2 | 1024.0 MiB | | 2021/04/22 18:08:13 | spark | FINISHED | 2 s |

### Completed Drivers (2)

| Submission ID | Submitted Time | Worker | State | Cores | Memory | Resources | Main Class |
|---|---|---|---|---|---|---|---|
| driver-20210422181809-0001 | 2021/04/22 18:18:09 | worker-20210422180507-10.4.1.4-37991 | FINISHED | 1 | 1024.0 MiB | | org.apache.spark.examples.JavaWordCount |

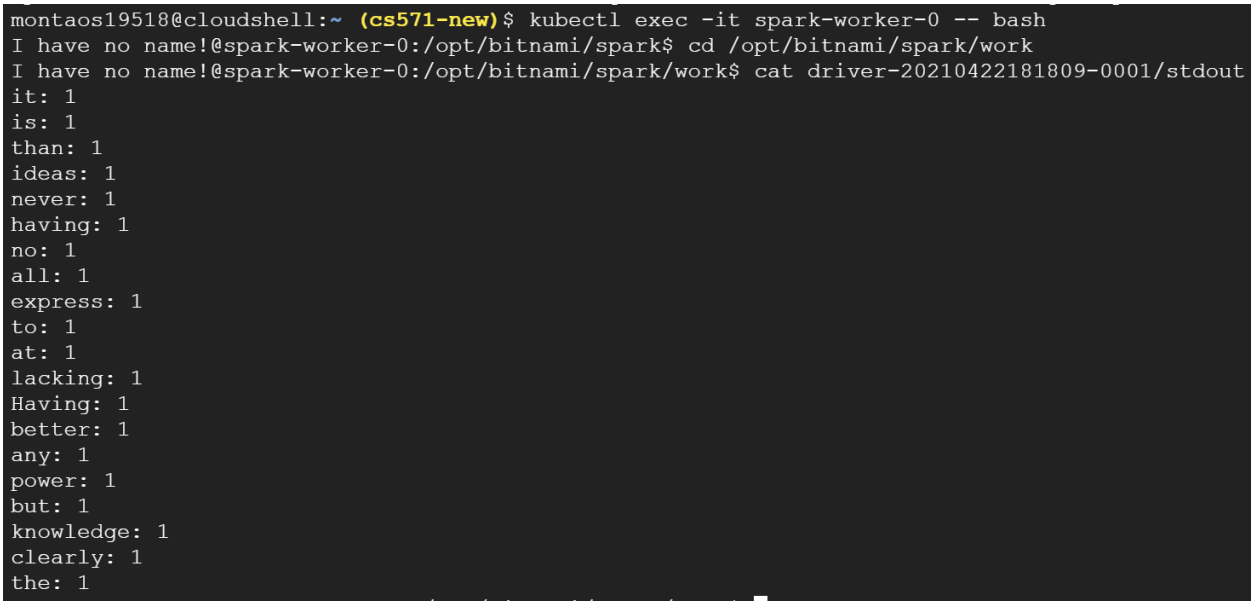
15. Get the name of the worker node

    `kubectl get pods -o wide | grep <worker node address>`

```
montaos19518@cloudshell:~ (cs571-new)$ kubectl get pods -o wide | grep 10.4.1.4
spark-worker-0                1/1     Running   0          15m   10.4.1.4    gke-spark-default-pool-69b5008a-7k9g   <none>           <none>
```

16. Execute the pod to see the result of the task

    `kubectl exec -it <spark-worker name> -- bash`
    `cd /opt/bitnami/spark/work`
    `cat <completed driver id >/stdout`


montaos19518@cloudshell:~ (cs571-new)$ kubectl exec -it spark-worker-0 -- bash
I have no name!@spark-worker-0:/opt/bitnami/spark$ cd /opt/bitnami/spark/work
I have no name!@spark-worker-0:/opt/bitnami/spark/work$ cat driver-20210422181809-0001/stdout
it: 1
is: 1
than: 1
ideas: 1
never: 1
having: 1
no: 1
all: 1
express: 1
to: 1
at: 1
lacking: 1
Having: 1
better: 1
any: 1
power: 1
but: 1
knowledge: 1
clearly: 1
the: 1