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Guide: Spark Cluster on AWS

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Abstract

This is a screenshot document of how to run an EMR Spark cluster and Spark scripts in the AWS environment.

Requirements

- **First you should have followed the Guide “First Access to AWS”.** It is assumed you already have an AWS account and a key pair, and you are familiar with the AWS EC2 environment.
- **Its is strongly recommended to firstly follow the Guide “Install Spark in Local Mode”** in order to get familiar with the Spark environment.
- We strongly recommend cluster instances with at least 4 vCPUs (**m4.xlarge**) to be able to evaluate parallel implementation within each node.

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1. Launch Hadoop EMR cluster

- Go to the EMR dashboard and click “Create cluster”. We recommend the following configuration
 - ClusterName: MySpark
 - Launch mode “Cluster”
 - Release: **5.29.0**
 - Applications: Spark
 - Instance type: m4.xlarge
 - Number of Instances: 3
 - Key pair: course-key (or any other key you want to use, see Guide “First Access to AWS”)
- **Make sure to select EMR release 5.29.0**

General Configuration

Cluster name

Logging ⓘ

S3 folder

Launch mode Cluster ⓘ Step execution ⓘ

Software configuration

Release ⓘ

Applications

- Core Hadoop: Hadoop 2.8.5 with Ganglia 3.7.2, Hive 2.3.6, Hue 4.4.0, Mahout 0.13.0, Pig 0.17.0, and Tez 0.9.2
- HBase: HBase 1.4.10 with Ganglia 3.7.2, Hadoop 2.8.5, Hive 2.3.6, Hue 4.4.0, Phoenix 4.14.3, and ZooKeeper 3.4.14
- Presto: Presto 0.227 with Hadoop 2.8.5 HDFS and Hive 2.3.6 Metastore
- Spark: Spark 2.4.4 on Hadoop 2.8.5 YARN with Ganglia 3.7.2 and Zeppelin 0.8.2

Use AWS Glue Data Catalog for table metadata ⓘ

- Click on “Create Cluster”



CS205: Computing Foundations for Computational Science, Spring 2021

Clone Terminate AWS CLI export

Cluster: MySpark **Starting**

Summary Application history Monitoring Hardware Configurations Events Steps Bootstrap actions

Connections: --
Master public DNS: --
History service: --
Tags: -- [View All / Edit](#)

Summary	Configuration details	Network and hardware
ID: j-1MCQPLD0H1CV7 Creation date: 2020-03-04 18:00 (UTC+1) Elapsed time: 0 seconds After last step: Cluster waits completes: Termination protection: Off Change	Release label: emr-5.29.0 Hadoop distribution: Amazon Applications: Ganglia 3.7.2, Spark 2.4.4, Zeppelin 0.8.2 Log URI: s3://aws-logs-196331178428-us-east-1/elasticmapreduce/ EMRFS consistent view: Disabled Custom AMI ID: --	Availability zone: -- Subnet ID: subnet-38252002 Master: Provisioning 1 m4.xlarge Core: Provisioning 2 m4.xlarge Task: --

Security and access

Key name: course-key

EC2 instance profile: EMR_EC2_DefaultRole
EMR role: EMR_DefaultRole

Visible to all users: All [Change](#)

Security groups for Master:

Security groups for Core & Task:

- Wait for the cluster to be ready. The cluster is ready when its state is "Waiting" and the Master and Core under the Networks and hardware section are both in "Running" state

Cluster: MySpark **Waiting** Cluster ready after last step completed.

Summary Application history Monitoring Hardware Configurations Events Steps Bootstrap actions

Connections: [Enable Web Connection](#) – Zeppelin, Spark History Server, Ganglia, Resource Manager ... (View All)
Master public DNS: ec2-54-160-121-207.compute-1.amazonaws.com [SSH](#)
History service: [Spark history server UI](#) (SSH tunneling not required)
Tags: -- [View All / Edit](#)

Summary	Configuration details	Network and hardware
ID: j-1MCQPLD0H1CV7 Creation date: 2020-03-04 18:00 (UTC+1) Elapsed time: 7 minutes After last step: Cluster waits completes: Termination protection: Off Change	Release label: emr-5.29.0 Hadoop distribution: Amazon Applications: Ganglia 3.7.2, Spark 2.4.4, Zeppelin 0.8.2 Log URI: s3://aws-logs-196331178428-us-east-1/elasticmapreduce/ EMRFS consistent view: Disabled Custom AMI ID: --	Availability zone: us-east-1a Subnet ID: subnet-38252002 Master: Running 1 m4.xlarge Core: Running 2 m4.xlarge Task: --

Security and access

Key name: course-key

EC2 instance profile: EMR_EC2_DefaultRole
EMR role: EMR_DefaultRole

Visible to all users: All [Change](#)

Security groups for Master: [sg-f02adb8f](#) (ElasticMapReduce-master)

Security groups for Core & Task: [sg-ee2adb91](#) (ElasticMapReduce-slave)



2. Login to the cluster

- Copy the “Master public DNS” SSH into the machine using your CS205-key. Note that the user you are logging into is `hadoop` not `ubuntu`

```
Summary
-----
ID: j-2FYY2J31ZK8BG
Creation date: 2021-03-31 11:11 (UTC-4)
Elapsed time: 18 minutes
After last step completes: Cluster waits
Termination protection: Off Change
Tags: -- View All / Edit
Master public DNS: ec2-100-24-206-111.compute-1.amazonaws.com
Connect to the Master Node Using SSH
```

```
$ ssh -i ~/.ssh/CS205-key.pem hadoop@ec2-100-24-206-111.compute-1.amazonaws.com
```

- If you could not login then make sure that the security groups (firewalls) of the EMR cluster opens the port 22 to the outside world (see Guide “First Access to AWS”)

```
nacho — hadoop@ip-10-2-1-183:~ — ssh -i ~/.ssh/course-key.pem hadoop@ec2-107-23-71-26.compute-1.amazonaws.com — 90x24
  _ | _ | _ )
  _ | (   /   Amazon Linux AMI
  __| \__|__|

https://aws.amazon.com/amazon-linux-ami/2017.03-release-notes/
11 package(s) needed for security, out of 15 available
Run "sudo yum update" to apply all updates.

EEEEEEEEEEEEEEEEEEEE MMMMMMMM          MMMMMMMM RRRRRRRRRRRRRRRR
E::::::::::::::::::E M:::::M          M:::::M R:::::R
EE:::::EEEEEEEEEE::E M:::::M          M:::::M R:::::R
E::::E          EEEEE M:::::M          M:::::M RR::::R      R::::R
E::::E          M:::::M:::M M:::M:::::M R:::R      R::::R
E:::::EEEEEEEEEE M:::::M M:::M M:::M M:::::M R:::RRRRRR::::R
E:::::EEEEEEEEEE M:::::M M:::M M:::::M R:::::RR
E::::E          M:::::M M:::M M:::::M R:::R      R::::R
E::::E          EEEEE M:::::M      MMM M:::::M R:::R      R::::R
EE:::::EEEEEEEE::E M:::::M          M:::::M R:::R      R::::R
E:::::EEEEEEEEEE M:::::M          M:::::M RR::::R      R::::R
EEEEEEEEEEEEEEEEEEEE MMMMMMMM          MMMMMMMM RRRRRRR      RRRRRR

[hadoop@ip-10-2-1-183 ~]$
```

3. Submit a Spark Script

- This section shows how to submit spark jobs to a hadoop-powered spark framework using the command line interface from the master (front-end) node. See that in this case the Spark framework reads from and writes to a hadoop file system.
- Upload to the master VM the Spark [wordcount.py](#) script and the [input.txt](#) file with the ebook of Moby Dick used in the MapReduce labs
- Upload the `input.txt` file to the Hadoop file system



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```
$ hadoop fs -put input.txt
```

```
$ hadoop fs -ls
```

```
Found 2 items
```

```
drwxr-xr-x  - hadoop hadoop          0 2017-09-07 15:38 .sparkStaging
-rw-r--r--  1 hadoop hadoop      16668 2017-09-07 16:26 input.txt
```

- **Submit the job**

```
$ spark-submit wordcount.py
```

```
17/09/07 16:52:42 INFO SparkContext: Running Spark version 2.2.0
```

```
17/09/07 16:52:42 INFO SparkContext: Submitted application: WordCount
```

```
17/09/07 16:52:42 INFO SecurityManager: Changing view acls to: hadoop
```

```
17/09/07 16:52:42 INFO SecurityManager: Changing modify acls to: hadoop
```

```
17/09/07 16:52:42 INFO SecurityManager: Changing view acls groups to:
```

```
17/09/07 16:52:42 INFO SecurityManager: Changing modify acls groups to:
```

```
...
```

- **When the program finishes, check the hadoop file system again and look for the `output.txt` file (actually it is a folder containing the output files). Note that if we run the program again, it will fail unless `output.txt` is removed first. To remove `output.txt` use: `hadoop fs -rm -R -f output.txt`**

```
$ hadoop fs -ls
```

```
Found 3 items
```

```
drwxr-xr-x  - hadoop hadoop          0 2017-09-07 15:38 .sparkStaging
-rw-r--r--  1 hadoop hadoop      16668 2017-09-07 16:26 input.txt
drwxr-xr-x  - hadoop hadoop          0 2017-09-07 16:55 output.txt
```

- **Download the file from hadoop file system to the local file system and check the content**

```
$ hadoop fs -get output.txt
```

```
$ cat output.txt/*
```

```
('swimming', 1)
```

```
('seemed', 1)
```

```
('pilot', 1)
```

```
('told', 3)
```

```
('balaene', 1)
```

```
('more', 4)
```

```
('history', 3)
```

```
('man', 2)
```

```
('wine', 1)
```

```
('speak', 1)
```

```
('quantity', 2)
```

```
('out', 7)
```

```
('davenant', 1)
```

- **You have just executed the job on the master node but however you have NOT used the worker**

nodes yet.

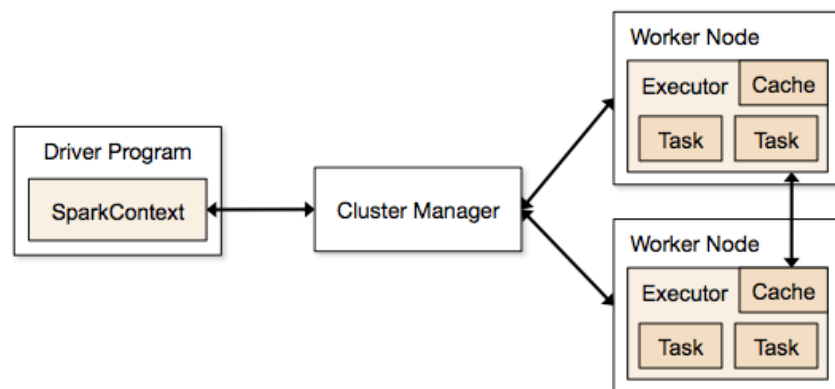
4. Parallel Execution on Multiple Nodes

Firstly see discussion about partitions, tasks and executors in the Guide “Start Spark in Local Mode”. When using the Yarn Cluster Mode:

- The number of cores (threads within each executor) can be specified with the `--executor-cores` flag when invoking `spark-submit`, `spark-shell`, and `pyspark` from the command line, or by setting the `spark.executor.cores` property in the `spark-defaults.conf` file or on a `SparkConf` object. The `cores` property controls the number of concurrent tasks an executor can run.
- The number of executors (worker nodes) can be specified with the `--num-executors` command-line flag or `spark.executor.instances` configuration property.

For example, the following command will execute the script on 2 executors (worker nodes) with 4 threads per executor, achieving the execution of 8 simultaneous tasks (**when running a job on multiple nodes do NOT use the `setMaster` property with `local` in the `SparkConf` configuration**).

```
$ spark-submit --num-executors 2 --executor-cores 4 script
```



- Upload to the VM the Spark [pi.py](#) script, **remove the `setMaster` property in the `SparkConf` configuration to avoid local execution**, increase `N` to `100000000` to increase the CPU demand, and modify the code to use 16 partitions.

```
print sc.parallelize(xrange(N), 16).map(...
```

- Execute the code in the cluster, and calculate the speedup for 2 executors and 1, 2 and 4 threads per executor.

```
spark-submit --num-executors 2 --executor-cores 1 pi.py
```

- Resize the cluster (Hardware option) to have 4 worker nodes and calculate the speedup for 4 executors and 1, 2 and 4 threads per executor.

As sequential time to calculate the speed-up you can run the same code in local mode with only one thread (you should use `.setMaster("local[1]")` in the Spark configuration of the code).



Terminate the cluster when you are sure you are done for the day to avoid incurring charges