

## Data Science Infrastructures – Exercise 06

### Assignment I – Creating a Spark Cluster

Answer: After exporting the module path and loading the spark 3.4.0, I started the interactive shell with one cpu. The final version of my terminal with the beginning of the Scala expressions within the cell is shown below.

```
(base) shyamyadav@Shyams-MacBook-Pro ~ % ssh -i /Users/shyamyadav/u11766 u11766@login-mdc.hpc.gwdg.de
Enter passphrase for key '/Users/shyamyadav/u11766':
Summary of Changes After May 23 Downtime
=====

The Slurm controllers were changed. This means that jobs submitted before the
downtime that did not finish must be resubmitted and Slurm JobIDs have been
reset. The qos names have changed for SCC users, if you want to use a qos
please use the 'sacctmgr show qos' command to see the new names.

You will also see all the NHR partitions now. They are not usable for SCC users

If you have any questions or concerns about these changes, please don't
hesitate to reach out to us. We're always here to help. Happy computing!
-bash: warning: setlocale: LC_CTYPE: cannot change locale (UTF-8): No such file or directory
manpath: can't set the locale; make sure $LC_* and $LANG are correct
Creating ECDSA key for ssh
gwdul01:45 16:14:21 ~ > export MODULEPATH=/opt/sw/modules/21.12/scc/common:$MODULEPATH module load spark/3.4.0
-bash: export: `spark/3.4.0': not a valid identifier
gwdul01:45 16:17:56 ~ > export MODULEPATH=/opt/sw/modules/21.12/scc/common:$MODULEPATH
gwdul01:45 16:18:56 ~ > module load spark/3.4.0
gwdul01:45 16:19:09 ~ > spark-shell --master local[1]
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
24/06/06 16:20:05 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
Spark context Web UI available at http://gwdul01.global.gwdg.cluster:4040
Spark context available as 'sc' (master = local[1], app id = local-1717683606784).
Spark session available as 'spark'.
Welcome to

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version 3.4.0

Using Scala version 2.12.17 (OpenJDK 64-Bit Server VM, Java 17)
Type in expressions to have them evaluated.
Type :help for more information.

scala>
```

Figure 1 Creating a Spark Cluster

### Assignment II – Interactive Use of Spark

Answer: This is how I uploaded my melville.txt file into the HPC system.

```
(base) shyamyadav@Shyams-MacBook-Pro ~ % scp -i /Users/shyamyadav/u11766 /Users/shyamyadav/melville.txt u11766@login-mdc.hpc.gwdg.de:
Enter passphrase for key '/Users/shyamyadav/u11766':
melville.txt                                100% 1246KB  8.1MB/s  00:00
(base) shyamyadav@Shyams-MacBook-Pro ~ %
```

Figure 2 Uploading melville.txt into hpc

Then, I performed MapReduce on Spark Cluster as shown below.

```
gwdul02: 13:19:16 ~ > export MODULEPATH=/opt/sw/modules/21.12/scc/common:$MODULEPATH
gwdul02: 13:19:17 ~ > module load spark/3.4.0
gwdul02: 13:20:43 ~ > spark-shell --master local[1]
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
24/06/07 13:20:28 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
24/06/07 13:20:28 WARN Utils: Service 'SparkUI' could not bind on port 4040. Attempting port 4041.
Spark context Web UI available at http://gwdul02.global.gwdg.cluster:4041
Spark context available as 'sc' (master = local[1], app id = local-171799868222).
Spark session available as 'spark'.
Welcome to

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version 3.4.0

Using Scala version 2.12.17 (OpenJDK 64-Bit Server VM, Java 17)
Type in expressions to have them evaluated.
Type :help for more information.

scala> var map = sc.textFile("melville.txt").flatMapLine => line.split(" ").map(word => (word,1))
map: org.apache.spark.rdd.RDD[(String, Int)] = MapPartitionsRDD[3] at map at <console>:13
scala> var counts = map.reduceByKey(_+_).collect
counts: org.apache.spark.rdd.RDD[(String, Int)] = ShuffledRDD[4] at reduceByKey at <console>:23
scala> counts.saveAsTextFile("./output")
scala> gwdul02: 13:34:02 ~ > ls
melville.txt  output
```

Figure 3 MapReduce on Spark

Now, the last portion of the output file “part-00000” is shown below.

```
(burns,,2)
(finest,3)
(113.,2)
(oozy;,1)
(patent,2)
(poorly,1)
(tooth.,1)
(thoughts,,6)
(undertaker?",1)
(honors,1)
(flukes-it's,1)
(miserably,2)
(avast,4)
(Charity,,2)
(groups,1)
(magnanimity,1)
(clock's,1)
(lot,5)
(larceny,1)
(unrifled.,1)
(Pedro;,1)
(them,-however,1)
(Folios?,1)
(cumbrous,1)
(continues,2)
(bob,1)
(sea,139)
(Queequeg's,,1)
(it-run,,1)
(paused,11)
(waive,1)
(searching,1)
(hermetically,1)
(ice-isles,1)
(matter?,1)
(bat-both,1)
(thunderous,1)
(exasperating,2)
(majesty,,1)
(felt,,2)
(citation,1)
(clamped,1)
(unappropriated,1)
(-_A,2)
(chinks,1)
(woes,,1)
(understand,16)
("Aye!,2)
(singing,10)
(sir?,6)
(hostility,1)
(Frenchman's,2)
(scratching,2)
(memorable,2)
(stringy,1)
(thunder?,1)
(expresses.,1)
(silence,,6)
(Upper,1)
(that—" ,1)
(there?-Avast!,1)
(absolutely,3)
gwdu102:4 13:41:20 ~/output > █
```

Figure 4 Last portion of the output file "part-00000" after MapReduce

Also, I tried to download my output file using the following command. The results are also shown below.

```
(base) shyamyadav@Shyams-MacBook-Pro ~ % scp -r -i /Users/shyamyadav/u11766 u11766@login-mdc.hpc.gwdg.de:/home/uni88/hpc/shyam.rayyadav/u11766/output /Users/shyamyadav/
Enter passphrase for key '/Users/shyamyadav/u11766':
part-00000.crc 100% 344B 128.5KB/s 00:00
part-00000 100% 430KB 6.2MB/s 00:00
SUCCESS.crc 100% 8 0.8KB/s 00:00
(base) shyamyadav@Shyams-MacBook-Pro ~ %
```

Figure 5 Downloading the file from HPC to my local machine

## Assignment III – Run a Spark Job

Answer: At first the cluster with 4 workers was created. The batch job on HPC cluster, which contains Spark Cluster, in queue waiting is shown below.

```
gwdud102:76 16:52:35 ~ > scc_spark_deploy.sh -N 4 -t 01:00:00 --qos=normal
Submitted batch job 192738
gwdud102:76 16:53:21 ~ > squeue -u u11766
```

JOBID	PARTITION	NAME	USER	ST	TIME	NODES	NODELIST(REASON)
192738	fat	Spark	u11766	PD	0:00	4	(WaitingInQueue)

Figure 6 Queuing of my spark cluster in HPC

After checking the status of my squeue, we can see that my job lies in the last corner of the queue.

```
gwdud102:76 17:03:24 ~ > squeue
```

JOBID	PARTITION	NAME	USER	ST	TIME	NODES	NODELIST(REASON)
105432	fat	Spark	u11695	PD	0:00	1	(PartitionConfig)
172702	fat	Spark	u11771	PD	0:00	1	(PartitionConfig)
183364	fat	Spark	u11670	PD	0:00	4	(WaitingInQueue)
183959	fat	cesm_run	stesfay	PD	0:00	4	(WaitingInQueue)
186418	fat	Spark	u11690	PD	0:00	4	(PartitionConfig)
186705	fat	Spark	u11232	PD	0:00	4	(WaitingInQueue)
186709	fat	Spark	u11672	PD	0:00	4	(PartitionConfig)
188583	fat	Spark	u11625	PD	0:00	1	(WaitingInQueue)
188903	fat	jobscrip	ritter42	PD	0:00	1	(WaitingInQueue)
189165	fat	Spark	u11687	PD	0:00	1	(PartitionConfig)
189836	fat	Spark	u11232	PD	0:00	4	(WaitingInQueue)
189837	fat	Spark	u11672	PD	0:00	4	(PartitionConfig)
190024	fat	Spark	u11672	PD	0:00	4	(PartitionConfig)
190367	fat	Spark	u11634	PD	0:00	1	(WaitingInQueue)
191070	fat	sim_PNG_	cparsch	PD	0:00	1	(PartitionTimeLimit)
191069	fat	sim_PNG_	cparsch	PD	0:00	1	(PartitionTimeLimit)
191068	fat	sim_PNG_	cparsch	PD	0:00	1	(PartitionTimeLimit)
191067	fat	sim_PNG_	cparsch	PD	0:00	1	(PartitionTimeLimit)
191056	fat	install_	gzadmnbo	PD	0:00	1	(WaitingInQueue)
191678	fat	Spark	u11668	PD	0:00	1	(WaitingInQueue)
191811	fat	Spark	u11671	PD	0:00	4	(WaitingInQueue)
192738	fat	Spark	u11766	PD	0:00	4	(WaitingInQueue)
191295	fat	install_	gzadmnbo	PD	0:00	1	(Dependency)
170116_7	fat	Neff100K	mtost	R	1:10:48	1	dsu001
170116_8	fat	Neff100K	mtost	R	1:10:48	1	dsu001
170119_1	fat	Neff100K	mtost	R	1:10:48	1	dsu002
173033_9	fat	Neff100K	mtost	R	1:10:48	1	dsu002
173039_9	fat	Neff100K	mtost	R	1:10:48	1	dsu003
170112_8	fat	Neff100K	mtost	R	4:07:26	1	dfa010
170116_6	fat	Neff100K	mtost	R	4:07:26	1	dfa010
179174	fat	Spark	u11716	R	10:08	1	dsu001
170112_6	fat	Neff100K	mtost	R	6:51:09	1	dfa003
170112_7	fat	Neff100K	mtost	R	6:51:09	1	dfa003
170112_5	fat	Neff100K	mtost	R	9:23:49	1	dfa005
170110_4	fat	Neff100K	mtost	R	9:23:49	1	dfa005
170107_1	fat	Neff100K	mtost	R	9:26:49	1	dfa012
170110_3	fat	Neff100K	mtost	R	9:26:49	1	dfa012
149162_8	fat	chr3d_fa	vvaramo	R	2-05:11:32	1	gwd001
168101_[1-9]	fat+	metaeuk.	bheimbu	PD	0:00	1	(TopOfQueue)
192886	gpu	2024-06-	ikottla	CG	4:05	1	agg002
191060	gpu	install_	gzadmnbo	PD	0:00	1	(PartitionConfig)
191059	gpu	install_	gzadmnbo	PD	0:00	1	(PartitionConfig)
191298	gpu	install_	gzadmnbo	PD	0:00	1	(Dependency)
191297	gpu	install_	gzadmnbo	PD	0:00	1	(Dependency)
145857	gpu	ret_7	beinecke	R	1-18:45:56	1	agg003
145858	gpu	ret_8	beinecke	R	1-18:45:56	1	agg003
145859	gpu	ret_9	beinecke	R	1-18:45:56	1	agg003
145856	gpu	ret_4	beinecke	R	1-18:53:05	1	agg007

Figure 7 Queuing status of my Spark Clusters

Unfortunately, I could not complete the last part of this assignment – III because the assigned job is still in the queue. I am not sure how long would it take. It might take longer than expected, and the deadline is approaching. Therefore, I would like to submit my assignment with the tasks that I have completed so far.