



DS/CMPSC 410

Run Spark in Cluster Mode

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Running Spark in a Cluster Mode

spark-submit can use one of several cluster managers:

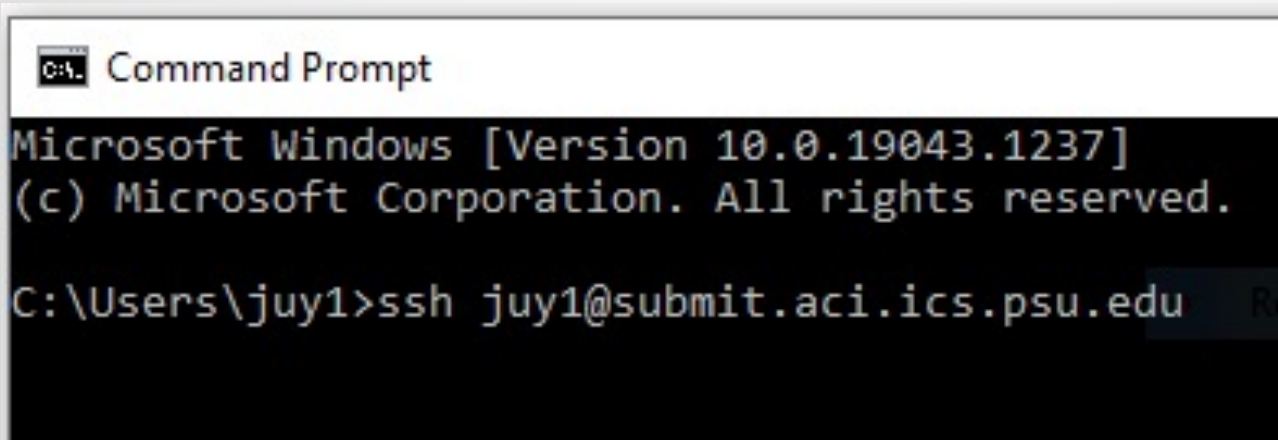
- **Spark standalone cluster** (this is the one we will use in Labs)
- Hadoop YARN: for running spark-submit in Hadoop using HDFS.
- Apache Mesos: a general cluster manager
- Kubernetes: an open-source system for containerized applications.

Modify Spark code (local mode) for Cluster mode (spark-submit)

- Remove `.master("local")` in `SparkSession` or `SparkContext`
- Modify input path (if needed because the data for cluster mode is typically larger).
- Modify output path (needed so that the output directories of cluster mode do not conflict with those generated by local mode)
- Remove all actions and Python codes used for debugging (or data exploration) purpose in the local mode, e.g.,
 - `show()`, `take()`, `printSchema()`, `print` a variable
- Add `persist()` for reused `RDD/DataFrame`, and `unpersist()` when they are not needed.

Steps to run spark-submit in ICDS cluster

- Open a terminal window (Command Prompt in PC)
- Type the following ssh command to the prompt
`ssh <YourPSUAccountName>@submit.aci.ics.psu.edu`



```
Command Prompt
Microsoft Windows [Version 10.0.19043.1237]
(c) Microsoft Corporation. All rights reserved.
C:\Users\juy1>ssh juy1@submit.aci.ics.psu.edu
```

Use Penn State password and 2 Factor Authentication

```
C:\> Command Prompt - ssh juy1@submit.aci.ics.psu.edu

Microsoft Windows [Version 10.0.19043.1237]
(c) Microsoft Corporation. All rights reserved.

C:\Users\juy1>ssh juy1@submit.aci.ics.psu.edu
The authenticity of host 'submit.aci.ics.psu.edu (146.186.1.73)' can't be established.
ECDSA key fingerprint is SHA256:Hn/+rL/6+LwCpyjWU4kYko99eVfyKiY9FZPUjs9HlvQ.
Are you sure you want to continue connecting (yes/no/[fingerprint])?
```

If you see the message above,

Enter: **yes**

Type ssh command again

```
C:\> Command Prompt - ssh juy1@submit.aci.ics.psu.edu

Microsoft Windows [Version 10.0.19043.1237]
(c) Microsoft Corporation. All rights reserved.

C:\Users\juy1>ssh juy1@submit.aci.ics.psu.edu
The authenticity of host 'submit.aci.ics.psu.edu (146.186.1.73)' can't be established.
ECDSA key fingerprint is SHA256:Hn/+rL/6+LwCpyjWU4kYko99eVfyKiY9FZPUjs9HlvQ.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'submit.aci.ics.psu.edu,146.186.1.73' (ECDSA) to the list
Connection closed by 146.186.1.73 port 22

C:\Users\juy1>ssh juy1@submit.aci.ics.psu.edu
***** W A R N I N G *****

This computer system is the property of the Pennsylvania State University. It
is for authorized use only. By using this system, all users acknowledge notice
of, and agree to comply with, the Institute for Computational and Data Science
Account Usage Policies, Data Policies, and relevant University Policies.

Unauthorized or improper use of this system may result in administrative
disciplinary action, civil charges/criminal penalties, and/or other sanctions
as set forth in University Policies. By continuing to use this system
you indicate your awareness of and consent to these terms and conditions of
use.

LOG OFF IMMEDIATELY if you do not agree to the conditions stated in
this warning.

***** W A R N I N G *****
Password:
```

After 2 Factor Authentication, you should log in successfully.

```
* * * * * W A R N I N G * * * * *
Password:
Password:
Duo two-factor login for juy1

Enter a passcode or select one of the following options:

1. Duo Push to XXX-XXX-0678
2. Phone call to XXX-XXX-0678
3. Phone call to XXX-XXX-6174
4. SMS passcodes to XXX-XXX-0678 (next code starts with: 5)

Passcode or option (1-4): 1
Success. Logging you in...
Last failed login: Mon Sep 20 14:36:31 EDT 2021 from 130.203.152.48 on ssh:notty
There were 2 failed login attempts since the last successful login.
Last login: Wed Sep  8 22:09:09 2021 from 10.40.144.190
[juy1@submit-002 ~]$
```

You are in your home directory of ICDS Roar.

- The same directory as you see in JupyterLab through ICDS portal:
- /storage/home/<YourPSUAccessID>

```
[juy1@submit-002 ~]$ pwd  
/storage/home/juy1  
[juy1@submit-002 ~]$
```

Request Resources for a Batch Job on ICDS Roar

Uppercase I of ICE Lowercase L/l of "LEAF/leaf"

`qsub -I -A open -l nodes=5:ppn=4 -l pmem=4gb -l walltime=1:00:00`

Notice the column

Suggested parameters: 5 nodes, 4 cores per node (ppn=4), 4gb of memory per node (pmem=4 G byte), 1 hour of walltime

It takes some time for approving the request, because it goes into a queue.

Resource is Ready

```
storage/home/juy1
[juy1@submit-002 ~]$ qsub -I -A open -l nodes=5:ppn=4 -l pmem=4gb -l walltime=1:00:00
Job will run under the 'open' account, as requested.
qsub: waiting for job 30955547.torque01.util.production.int.aci.ics.psu.edu to start
qsub: job 30955547.torque01.util.production.int.aci.ics.psu.edu ready
[juy1@comp-bc-0371 ~]$
```

- When the resource requested is made available to you, you will see a response similar to the one above.

Use change directory (cd) command to switch to the directory that contains your .py file for PySpark code

- pwd: print the path of current/working directory
- ls : (list) shows files and subdirectories in your current directory.
- cd Lab5 : change the current directory to be Lab5 subdirectory

```
[juy1@comp-bc-0371 ~]$ pwd
/storage/home/juy1
[juy1@comp-bc-0371 ~]$ cd Lab5
[juy1@comp-bc-0371 Lab5]$
```

Specify module to be used

1. Type the following to the terminal prompt

`module use /gpfs/group/RISE/sw7/modules`

2. Type the following to the terminal prompt to load spark

`module load spark`

```
[juy1@comp-bc-0371 Lab5]$ module use /gpfs/group/RISE/sw7/modules
[juy1@comp-bc-0371 Lab5]$ module load spark
[juy1@comp-bc-0371 Lab5]$
```

pbs-spark-submit

- We will use pbs-spark-submit
- We want to get run-time information, so we add time in front of the pbs-spark-submit.
- We want to save the execution log (including run time information at the end) in a log file so that we can investigate its content (for debug, performance comparison).
- `<command> & > log.txt`
- `>` redirects the output (from terminal) to the log file.
- `&` indicates to run the command in the background.
- `(time pbs-spark-submit Lab5B.py) &> Lab5B_log.txt`