Big Data Analytics at OSC

04/05/2018
SUG

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Data Analytics at OSC

Introduction:

- ❑ Data Analytical nodes
- ❑ OSC Ondemand

Applications:

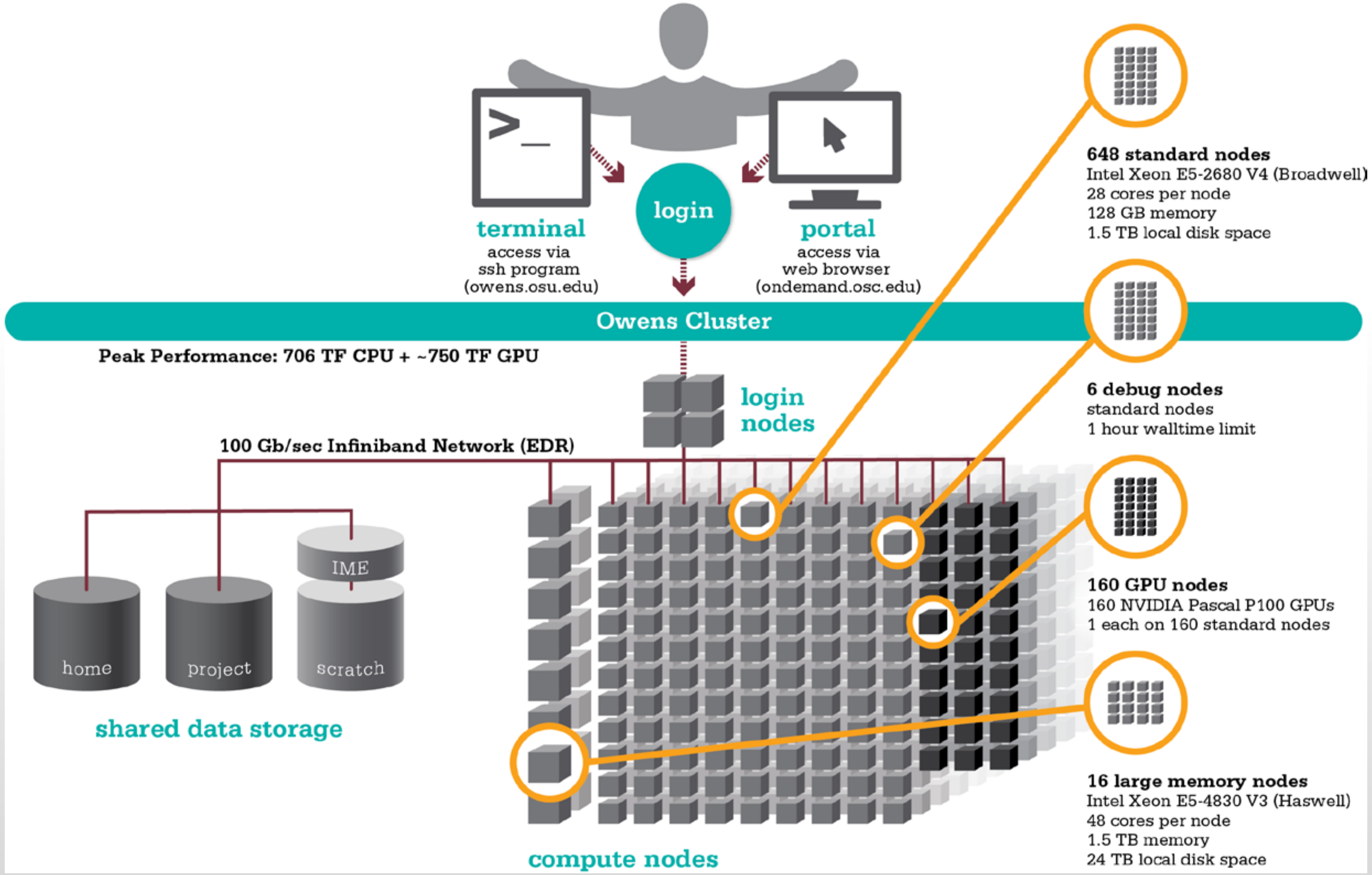
- ❑ R
- ❑ Spark
- ❑ Hadoop

Howto:

- ❑ Rstudio on Ondemand
- ❑ Spark on Ondemand

Data Analytical nodes

Owens' data analytics environment is comprised of 16 nodes, each with 48 CPU cores, 1.5TB of RAM and 24TB of local disk.



Storage Options:

$HOME:
500GB
Backed up daily
Permanent storage

Local disk:$TMPDIR
1.5TB or 24TB
Not backed up
Temporary storage

/fs/scratch:
1200TB
Not backed up
Temporary storage

/fs/project:
Upon request
1-5TB
Backed up daily
1-3 years

OSC OnDemand ondemand.osc.edu

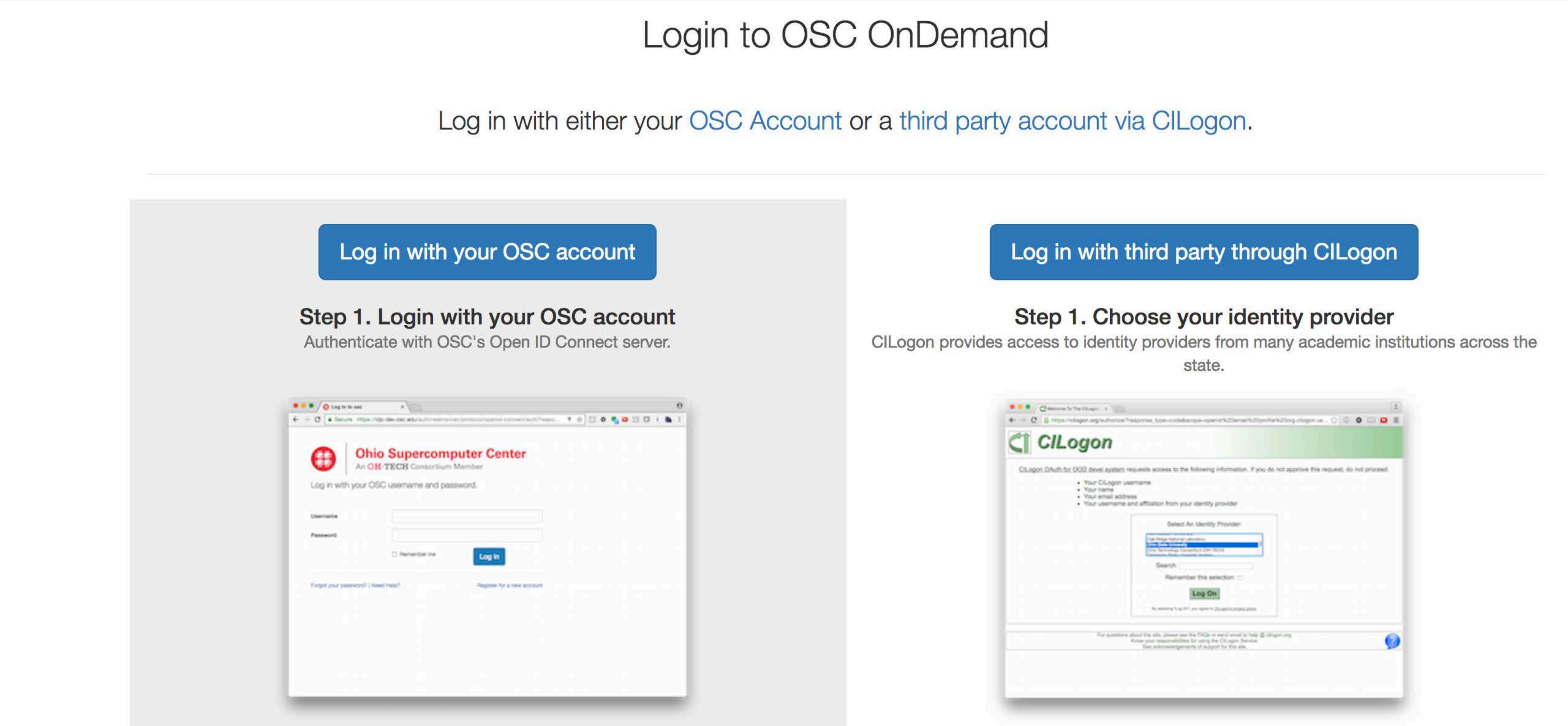
- 1: User Interface
  - Web based
    - Usable from computers, tablets, smartphones
    - Zero installation
  - Single point of entry
    - User needs three things
      - ondemand.osc.edu
      - OSC Username
      - OSC Password
    - Connected to all resources at OSC

- 2: Interactive Services
  - File Access
  - Job Management
  - Visualization Apps
    - Desktop access
    - Single-click apps (Abaqus, Ansys, Comsol, Paraview)
  - Terminal Access

Tutorial available at

osc.edu/ondemand

OSC OnDemand



Login to OSC OnDemand

Log in with either your OSC Account or a third party account via CILogon.

Log in with your OSC account

Step 1. Login with your OSC account

Authenticate with OSC's Open ID Connect server.

Log in to osc

Ohio Supercomputer Center
An OH·TECH Consortium Member

Log in with your OSC username and password.

Username

Password

□ Remember me

Log in

Forgot your password? | Need help?

Register for a new account

Log in with third party through CILogon

Step 1. Choose your identity provider

CILogon provides access to identity providers from many academic institutions across the state.

CILogon

CILogon OAuth for OOD devel system requests access to the following information. If you do not approve this request, do not proceed.

- Your CILogon username
- Your name
- Your email address
- Your username and affiliation from your identity provider

Select An Identity Provider:

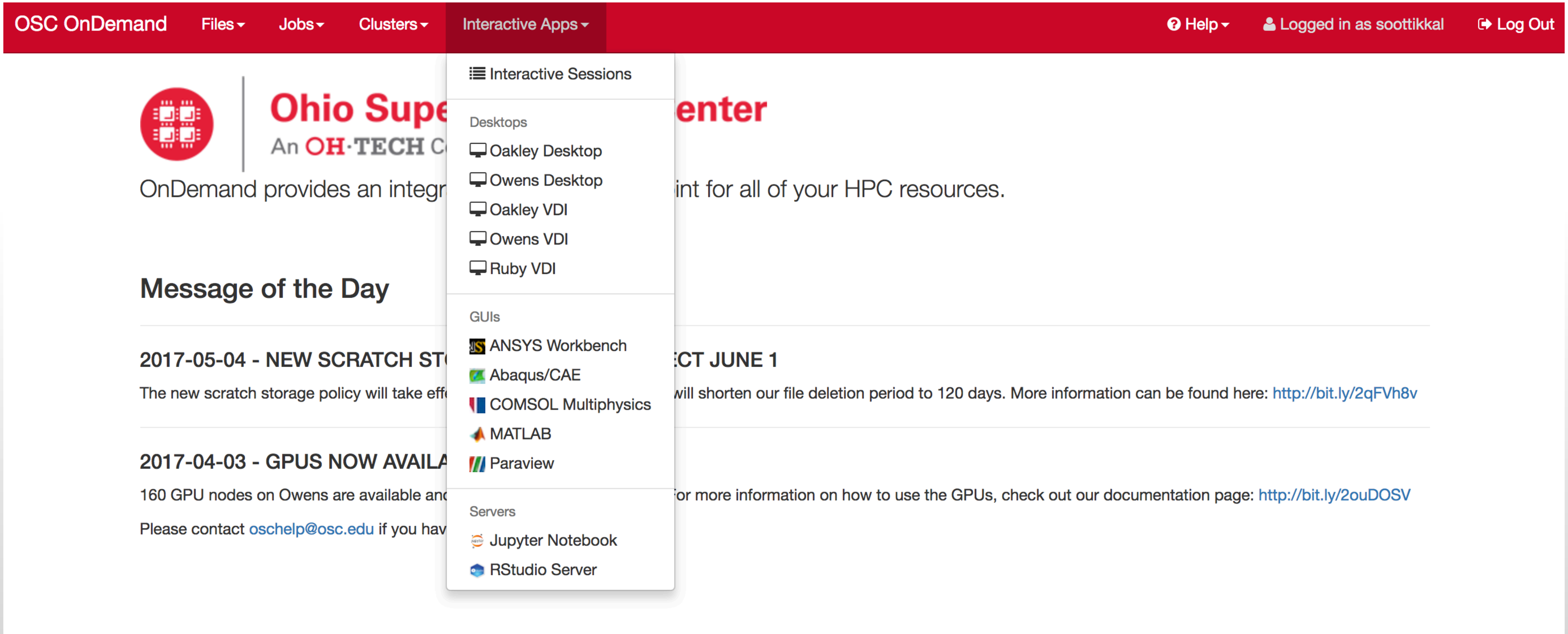
Oak Ridge National Laboratory
Ohio State University
Ohio Technology Consortium (OH-TECH)

Search:

Remember this selection: □

Log On

For questions about this site, please see the FAQs or send email to help @ cilogon.org
Know your responsibilities for using the CILogon Service.
See acknowledgements of support for this site.



OnDemand provides an integr int for all of your HPC resources.

Message of the Day

2017-05-04 - NEW SCRATCH ST ECT JUNE 1

The new scratch storage policy will take eff will shorten our file deletion period to 120 days. More information can be found here: http://bit.ly/2qFVh8v

2017-04-03 - GPUS NOW AVAILA

160 GPU nodes on Owens are available and or more information on how to use the GPUs, check out our documentation page: http://bit.ly/2ouDOSV

Please contact oschelp@osc.edu if you hav

Data Analytical Applications

Python: A popular general-purpose, high-level programming language with numerous mathematical and scientific packages available for data analytics

R: A programming language for statistical and machine learning applications with very strong graphical capabilities

MATLAB: A full featured data analysis toolkit with many advanced algorithms readily available

Spark and Hadoop: Big data Frameworks based on distributed storage

Intel Compilers: Compilers for generating optimized code for Intel CPUs.

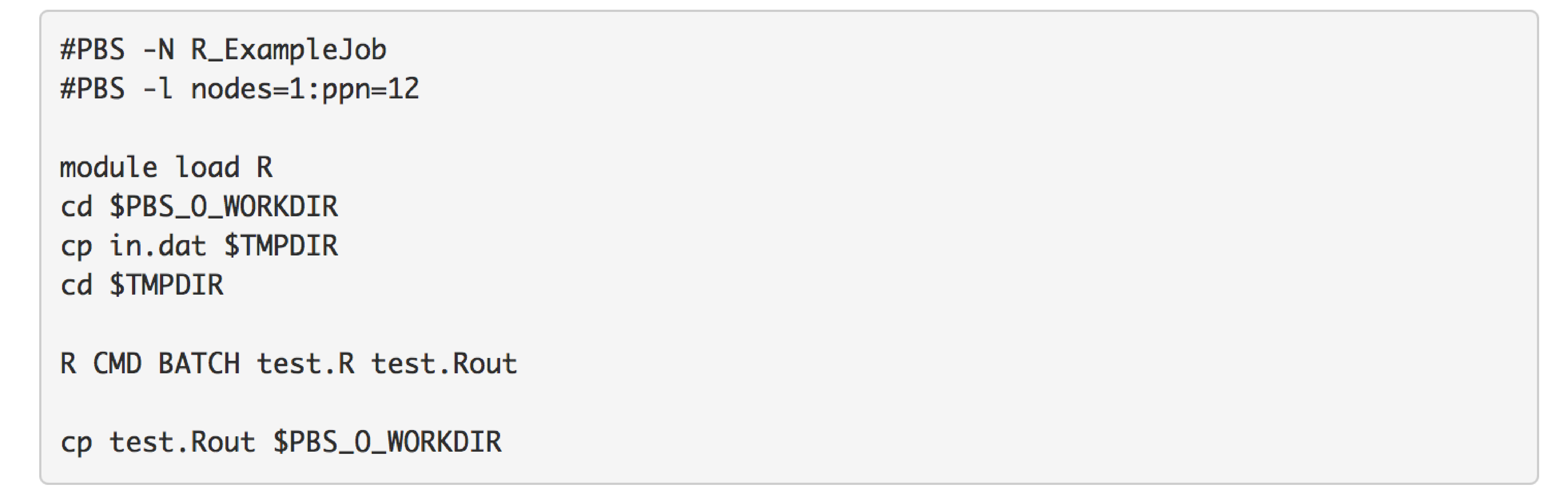
Intel MKL: The Math Kernel Library provides optimized subroutines for common computation tasks such as matrix-matrix calculations.

Statistical software: Octave, Stata, FFTW, ScaLAPACK, MINPACK, sprng2

R and Rstudio

R is a language and environment for statistical computing and graphics. R provides a wide variety of statistical and graphical techniques and is highly extensible.

Batch Usage



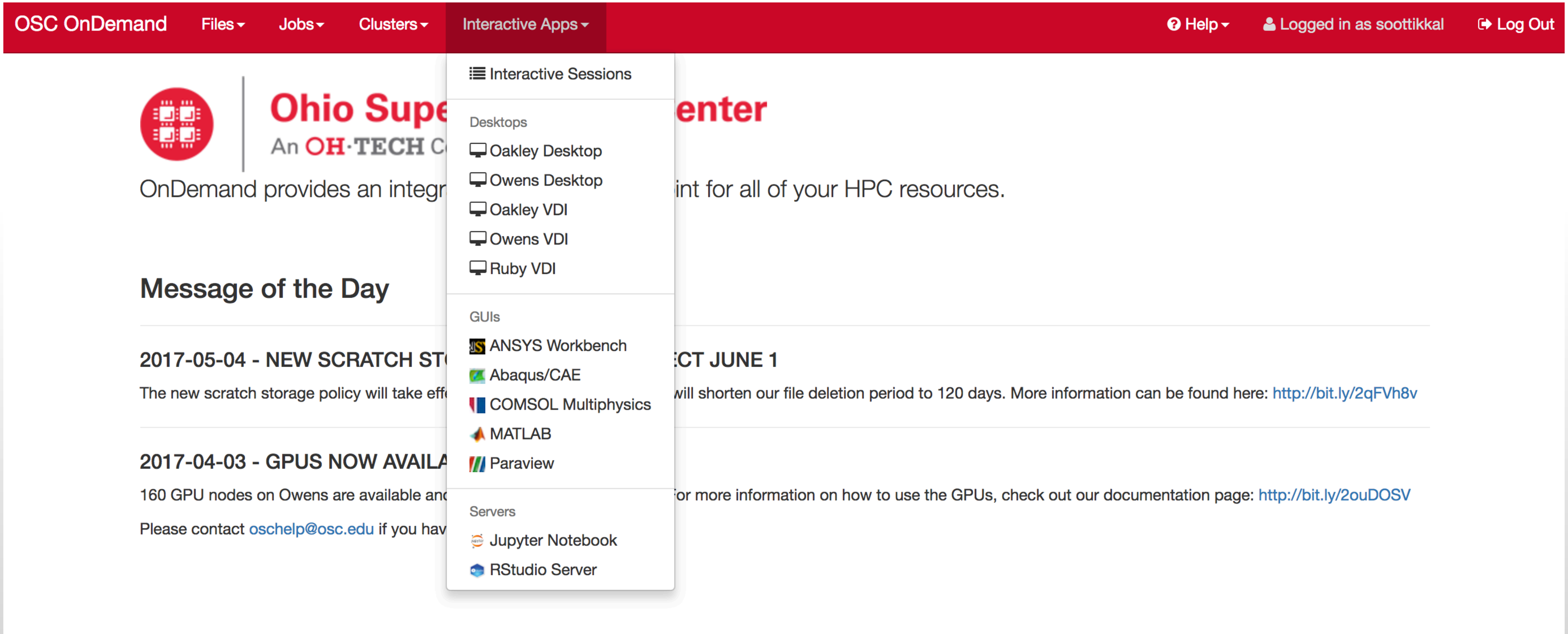
```
#PBS -N R_ExampleJob
#PBS -l nodes=1:ppn=12

module load R
cd $PBS_O_WORKDIR
cp in.dat $TMPDIR
cd $TMPDIR

R CMD BATCH test.R test.Rout

cp test.Rout $PBS_O_WORKDIR
```

Rstudio on Ondemand



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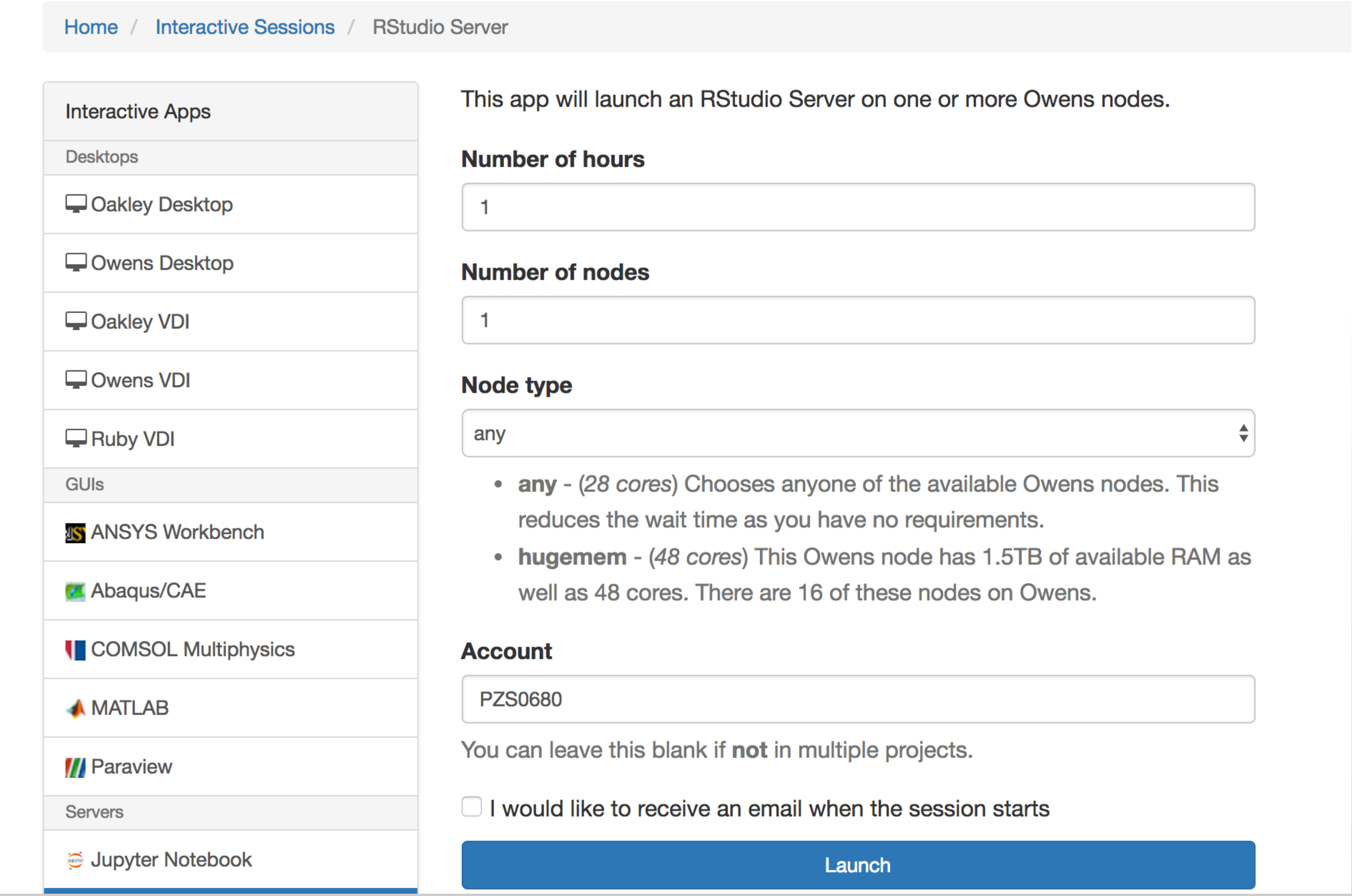
Please contact oschelp@osc.edu if you hav



Home / Interactive Sessions / RStudio Server

Interactive Apps

Desktops

- Oakley Desktop
- Owens Desktop
- Oakley VDI
- Owens VDI
- Ruby VDI

GUIs

- ANSYS Workbench
- Abaqus/CAE
- COMSOL Multiphysics
- MATLAB
- Paraview

Servers

- Jupyter Notebook

This app will launch an RStudio Server on one or more Owens nodes.

Number of hours

1

Number of nodes

1

Node type

any

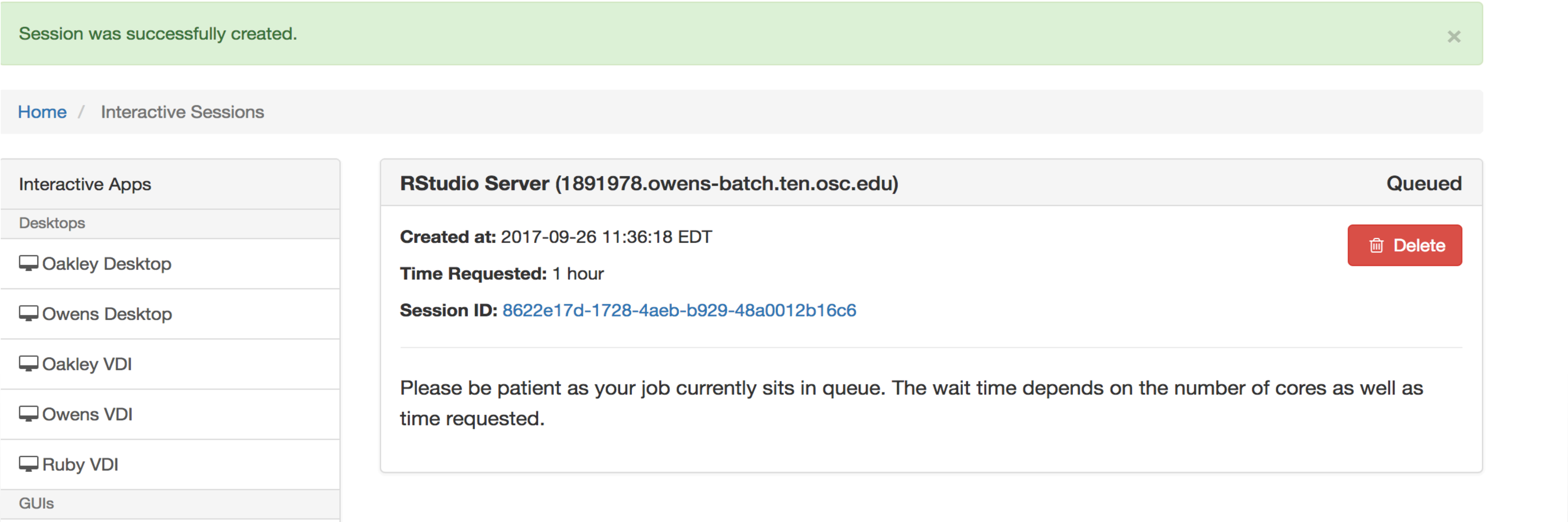
- **any** - (*28 cores*) Chooses anyone of the available Owens nodes. This reduces the wait time as you have no requirements.
- **hugemem** - (*48 cores*) This Owens node has 1.5TB of available RAM as well as 48 cores. There are 16 of these nodes on Owens.

Account

PZS0680

You can leave this blank if **not** in multiple projects.

□ I would like to receive an email when the session starts



Session was successfully created.

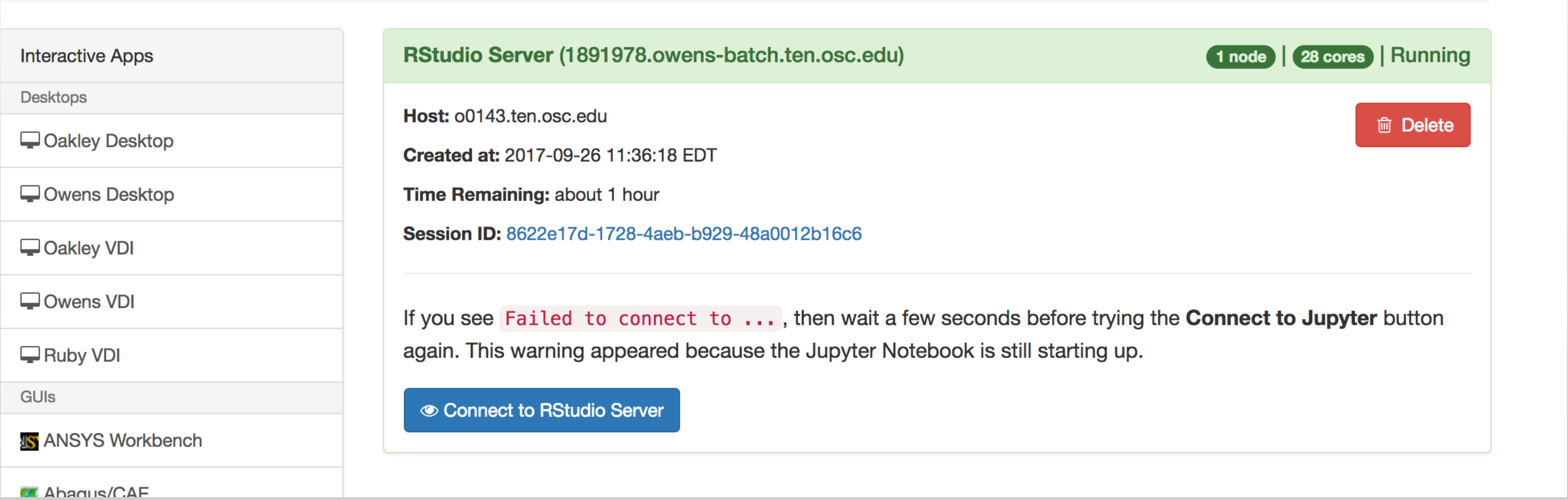
RStudio Server (1891978.owens-batch.ten.osc.edu) Queued

Created at: 2017-09-26 11:36:18 EDT

Time Requested: 1 hour

Session ID: 8622e17d-1728-4aeb-b929-48a0012b16c6

Please be patient as your job currently sits in queue. The wait time depends on the number of cores as well as time requested.



RStudio Server (1891978.owens-batch.ten.osc.edu) 1 node | 28 cores | Running

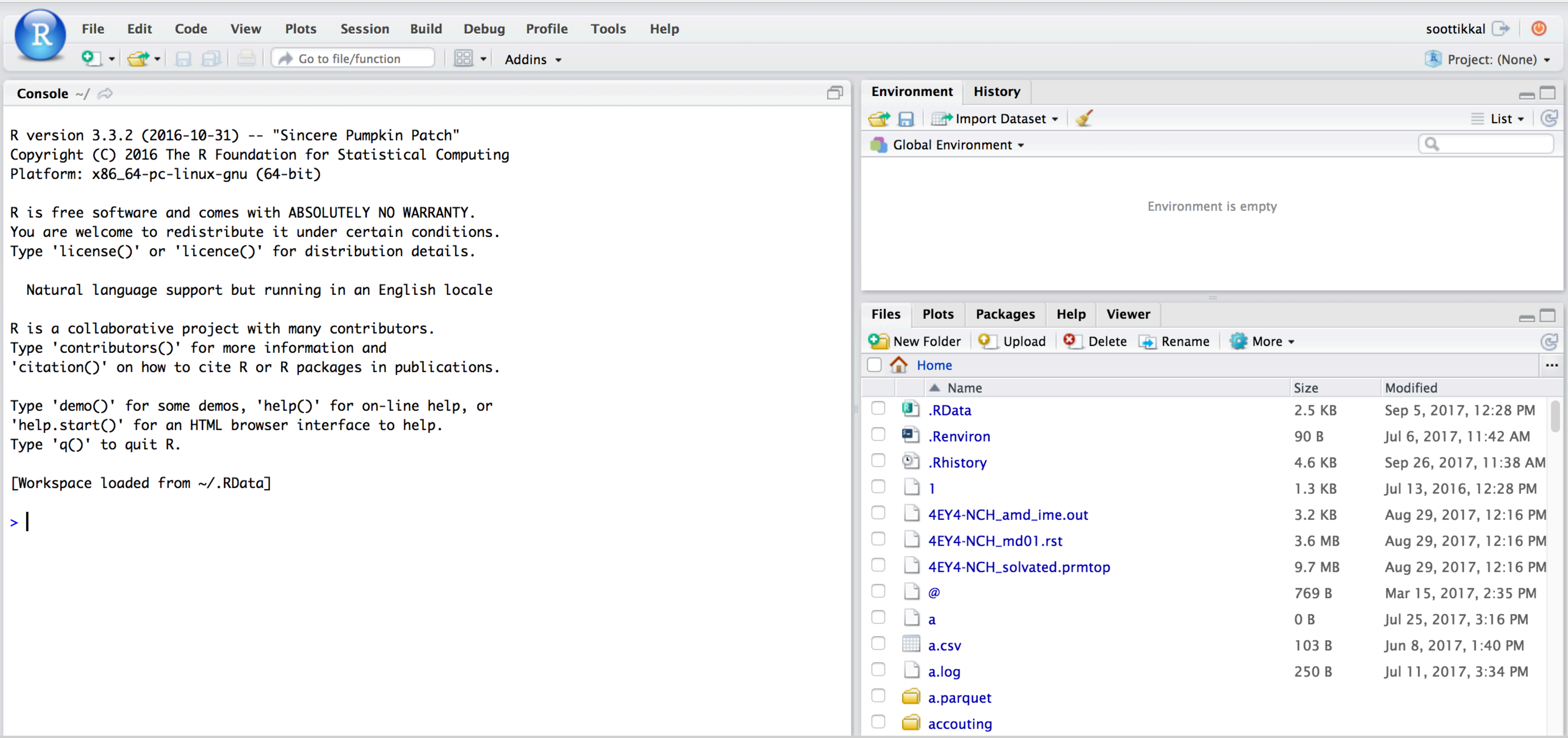
Host: o0143.ten.osc.edu

Created at: 2017-09-26 11:36:18 EDT

Time Remaining: about 1 hour

Session ID: 8622e17d-1728-4aeb-b929-48a0012b16c6

If you see `Failed to connect to ...`, then wait a few seconds before trying the **Connect to Jupyter** button again. This warning appeared because the Jupyter Notebook is still starting up.

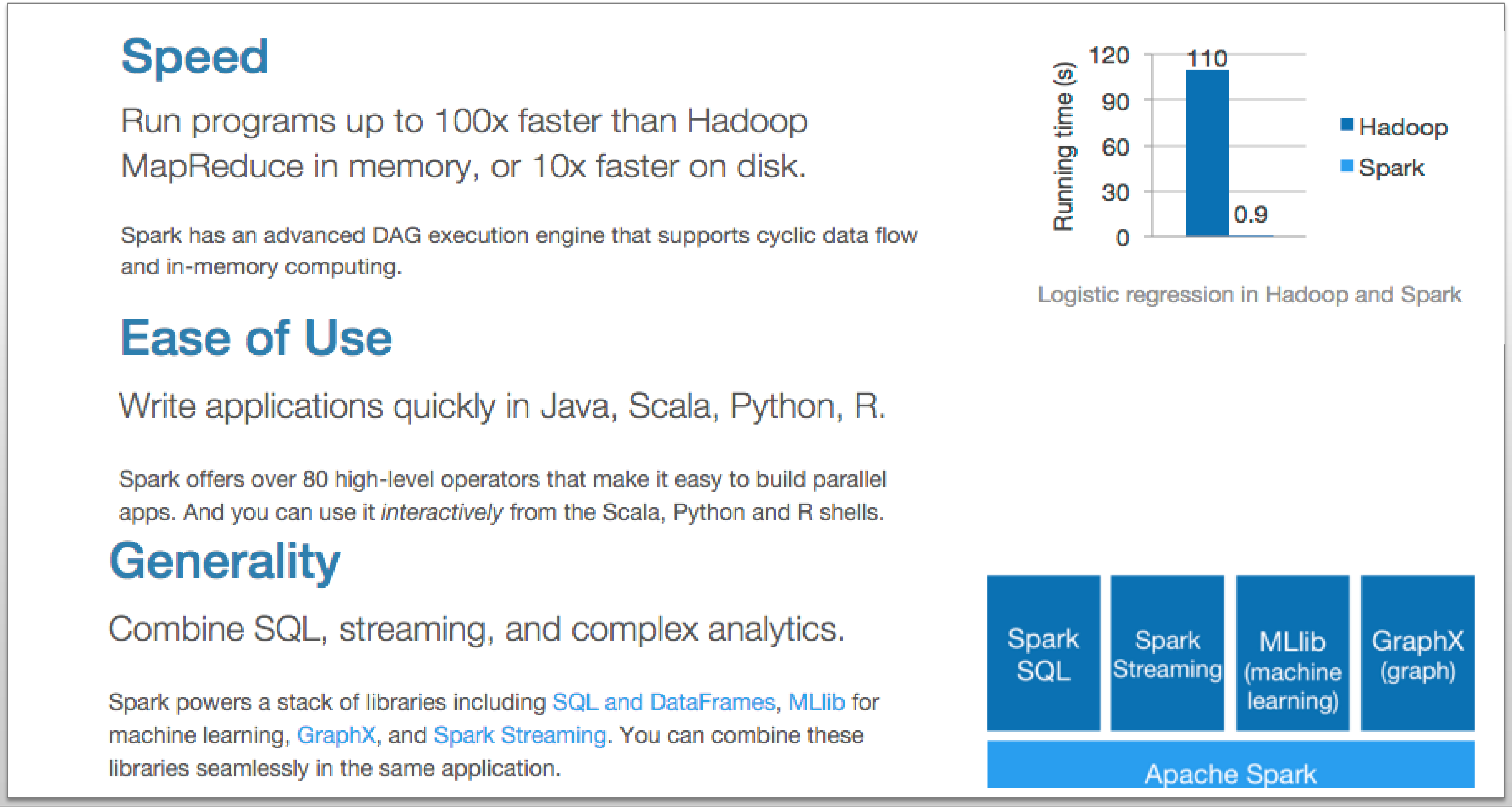


```
R version 3.3.2 (2016-10-31) -- "Sincere Pumpkin Patch"
Copyright (C) 2016 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Workspace loaded from ~/.RData]

> 
```

▲ Name	Size	Modified
.RData	2.5 KB	Sep 5, 2017, 12:28 PM
.Renviron	90 B	Jul 6, 2017, 11:42 AM
.Rhistory	4.6 KB	Sep 26, 2017, 11:38 AM
1	1.3 KB	Jul 13, 2016, 12:28 PM
4EY4-NCH_amd_ime.out	3.2 KB	Aug 29, 2017, 12:16 PM
4EY4-NCH_md01.rst	3.6 MB	Aug 29, 2017, 12:16 PM
4EY4-NCH_solvated.prmtop	9.7 MB	Aug 29, 2017, 12:16 PM
@	769 B	Mar 15, 2017, 2:35 PM
a	0 B	Jul 25, 2017, 3:16 PM
a.csv	103 B	Jun 8, 2017, 1:40 PM
a.log	250 B	Jul 11, 2017, 3:34 PM
a.parquet		
accouting		

Apache Spark

Apache Spark is an open source cluster computing framework originally developed in the AMPLab at University of California, Berkeley but was later donated to the Apache Software Foundation where it remains today. In contrast to Hadoop's disk-based analytics paradigm, Spark has multi-stage in-memory analytics.



Speed

Run programs up to 100x faster than Hadoop MapReduce in memory, or 10x faster on disk.

Spark has an advanced DAG execution engine that supports cyclic data flow and in-memory computing.

Logistic regression in Hadoop and Spark

Ease of Use

Write applications quickly in Java, Scala, Python, R.

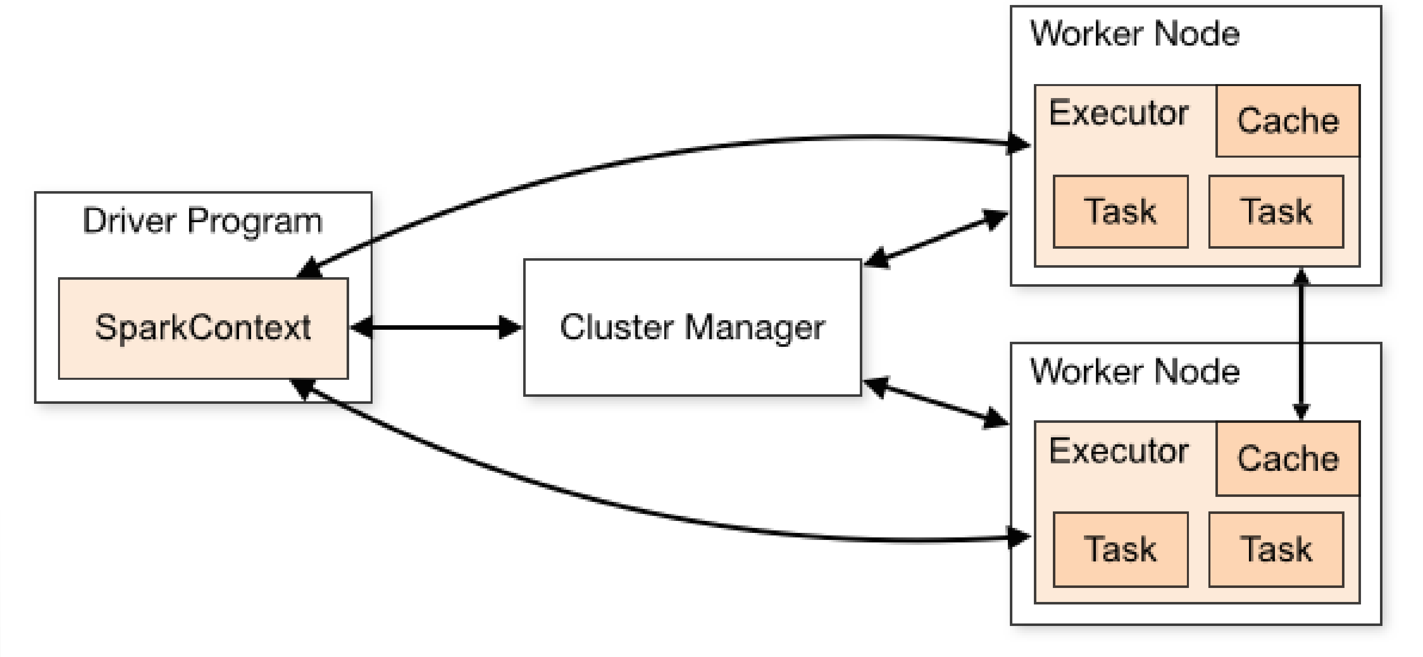
Spark offers over 80 high-level operators that make it easy to build parallel apps. And you can use it *interactively* from the Scala, Python and R shells.

Generality

Combine SQL, streaming, and complex analytics.

Spark powers a stack of libraries including SQL and DataFrames, MLlib for machine learning, GraphX, and Spark Streaming. You can combine these libraries seamlessly in the same application.

Spark workflow



Spark applications run as independent sets of processes on a cluster, coordinated by the SparkContext object in your main program (called the driver program).

Requires cluster managers which allocate resources across applications.

Once connected, Spark acquires executors on nodes in the cluster, which are processes that run computations and store data for your application.

Next, it sends your application code (defined by JAR or Python files passed to SparkContext) to the executors. Finally, SparkContext sends tasks to the executors to run.

RDD- Resilient Distributed Datasets

RDD (Resilient Distributed Dataset) is the main logical data unit in Spark. They are

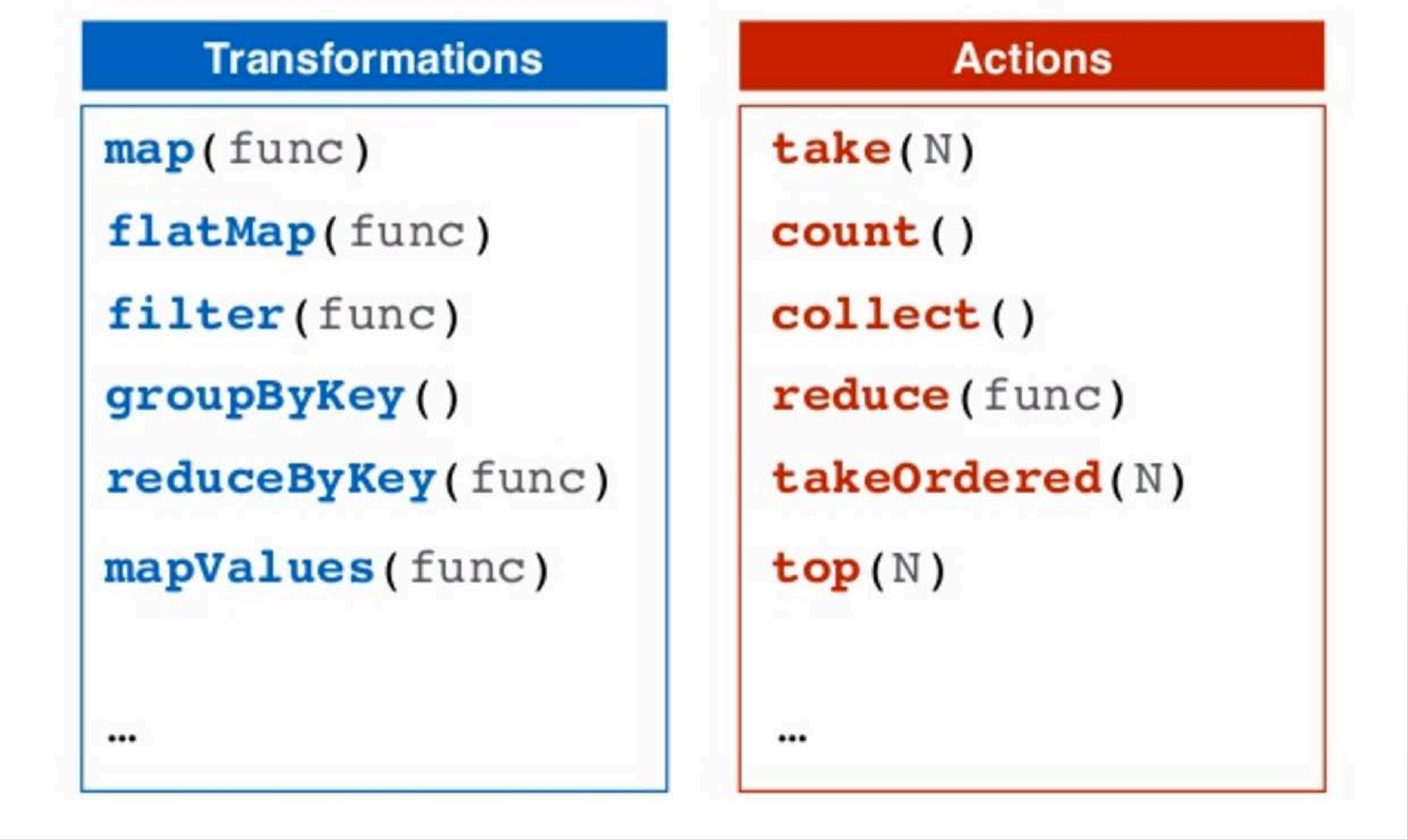
- Distributed and partitioned
- Stored in memory
- Immutable
- Partitions recomputed on failure

RDD- Transformations and Actions

Transformations are executed on demand. That means they are computed lazily. Eg: filter, join, sort

Actions return final results of RDD computations. Actions triggers execution using lineage graph to load the data into original RDD, carry out all intermediate transformations and return final results to Driver program or write it out to file system. Eg: collect(), count(), take()

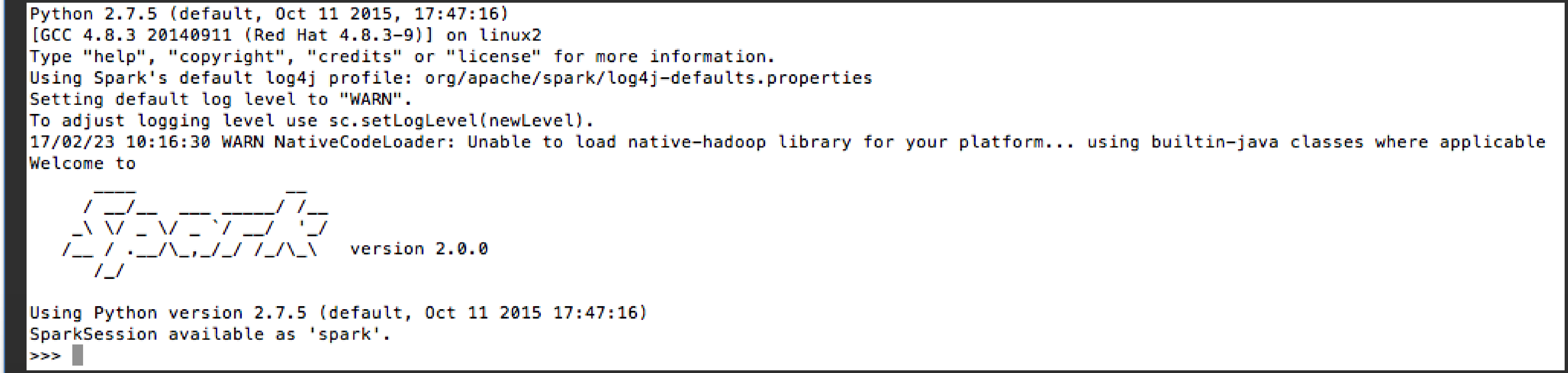
RDD Operations



Transformations	Actions
map(func)	take(N)
flatMap(func)	count()
filter(func)	collect()
groupByKey()	reduce(func)
reduceByKey(func)	takeOrdered(N)
mapValues(func)	top(N)
…	…

Interactive Analysis with the Spark Shell

$SPARK_HOME/bin/pyspark   # Opens SparkContext



```
Python 2.7.5 (default, Oct 11 2015, 17:47:16)
[GCC 4.8.3 20140911 (Red Hat 4.8.3-9)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
Using Spark's default log4j profile: org/apache/spark/log4j-defaults.properties
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel).
17/02/23 10:16:30 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 2.0.0
      /_/

Using Python version 2.7.5 (default, Oct 11 2015 17:47:16)
SparkSession available as 'spark'.
>>> 
```

1. Create a RDD

```
>>> data = sc.textFile("README.md")
```

2. Transformation of RDD

```
>>>linesWithSpark = data.filter(lambda line: "Spark" in line)
```

3. Action on RDD

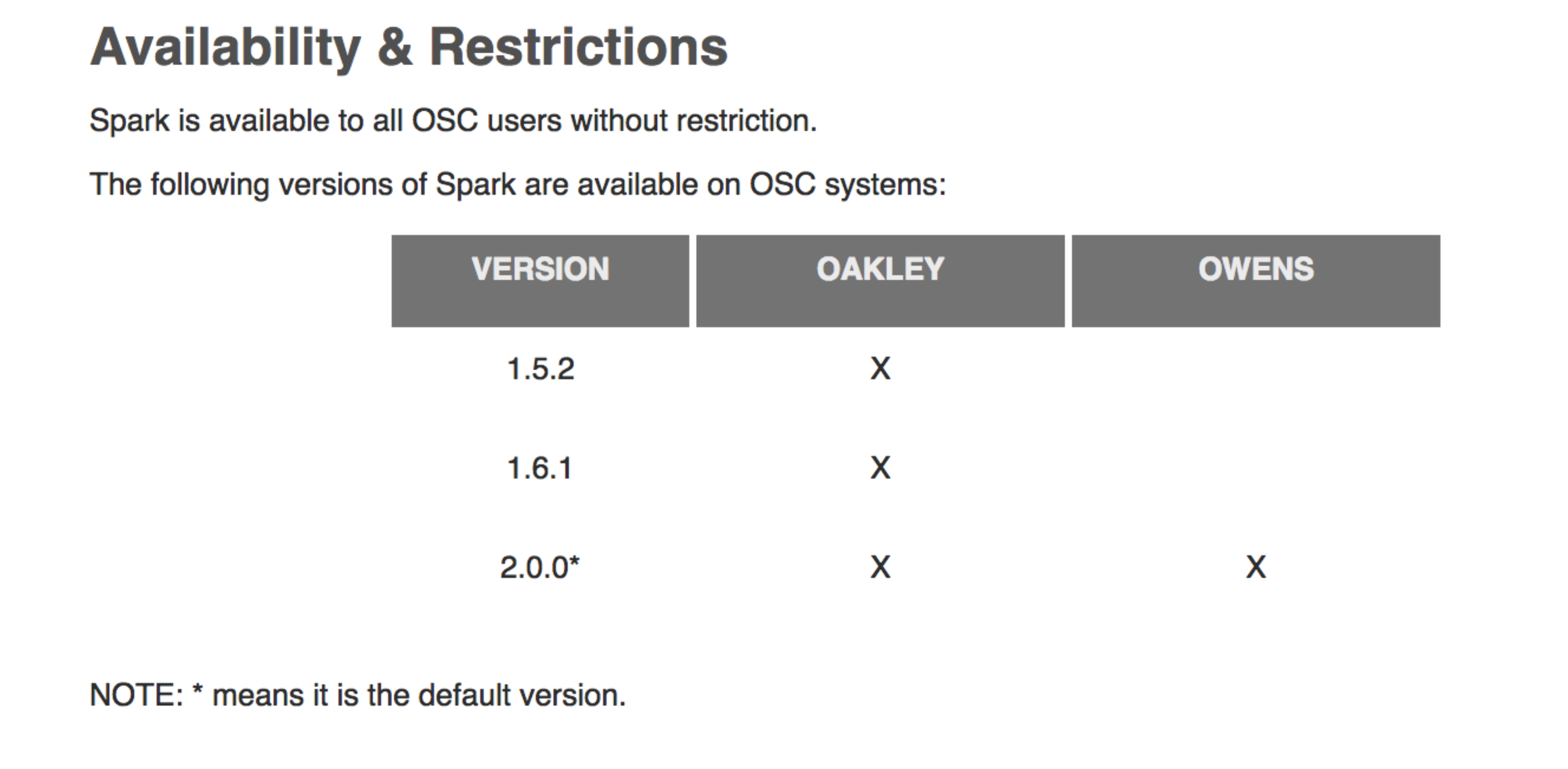
```
>>> linesWithSpark.count()   # Number of items in this RDD
12
```

4. Combining Transformation and Actions

```
>>> data.filter(lambda line: "Spark" in line).count() # How many lines contain "Spark"?
12
```

Spark documentation at OSC

https://www.osc.edu/resources/available_software/software_list/spark



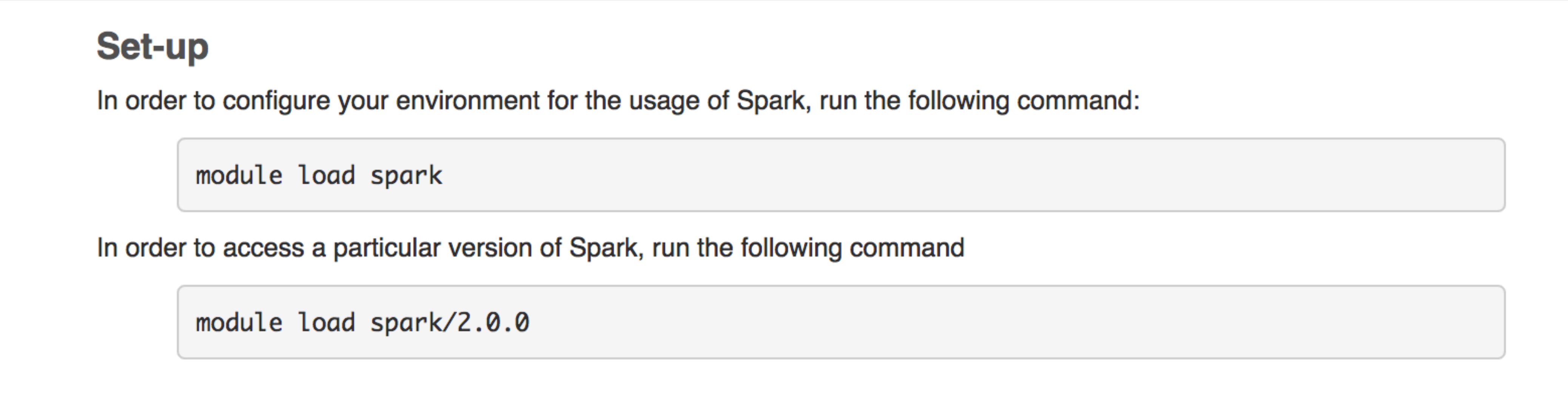
Availability & Restrictions

Spark is available to all OSC users without restriction.

The following versions of Spark are available on OSC systems:

VERSION	OAKLEY	OWENS
1.5.2	X	
1.6.1	X	
2.0.0*	X	X

NOTE: * means it is the default version.



Set-up

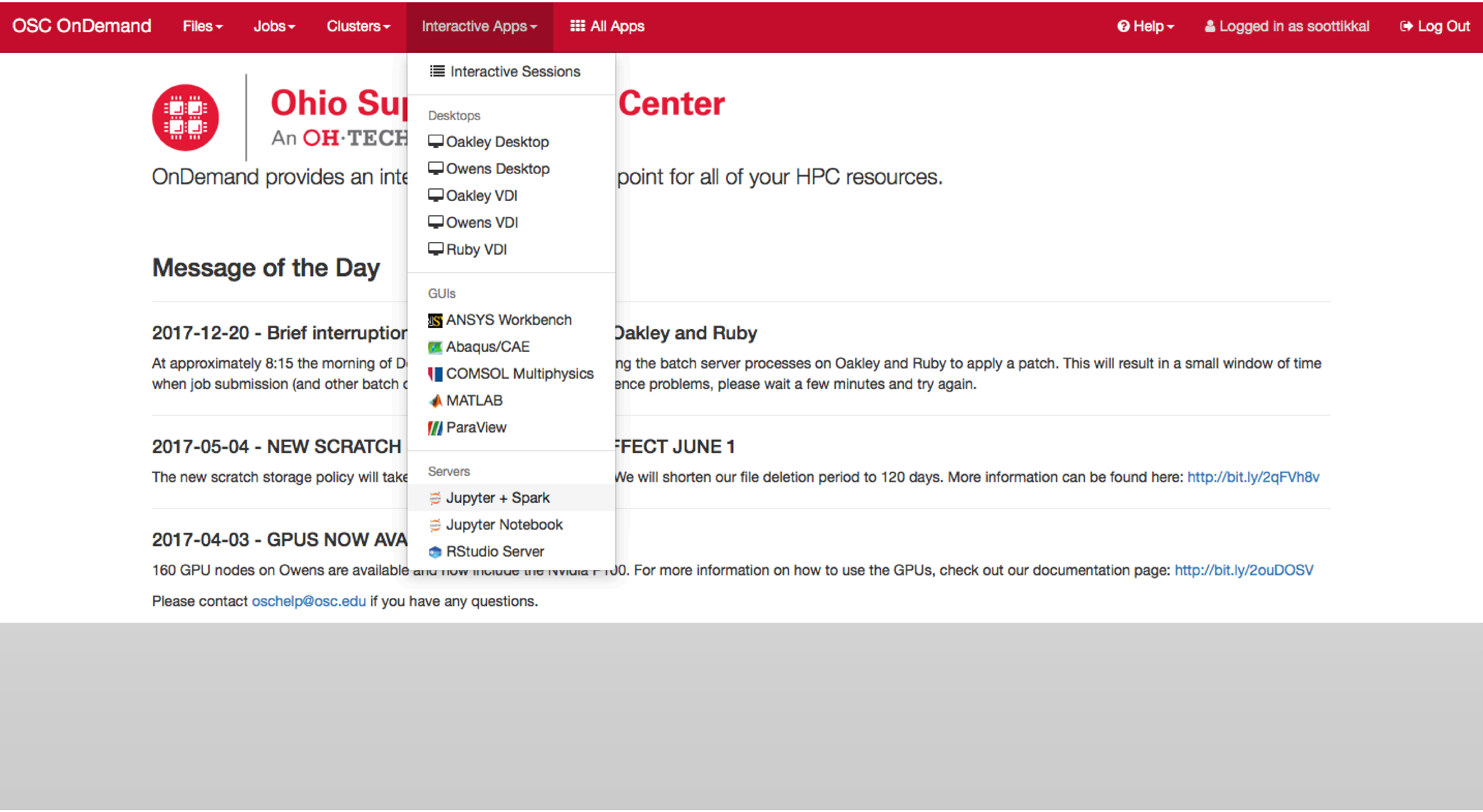
In order to configure your environment for the usage of Spark, run the following command:

```
module load spark
```

In order to access a particular version of Spark, run the following command

```
module load spark/2.0.0
```

Choose Jupyter+Spark app from the Interactive Apps option.



OnDemand provides an inte point for all of your HPC resources.

Message of the Day

2017-12-20 - Brief interruption Oakley and Ruby

At approximately 8:15 the morning of D ng the batch server processes on Oakley and Ruby to apply a patch. This will result in a small window of time when job submission (and other batch c ence problems, please wait a few minutes and try again.

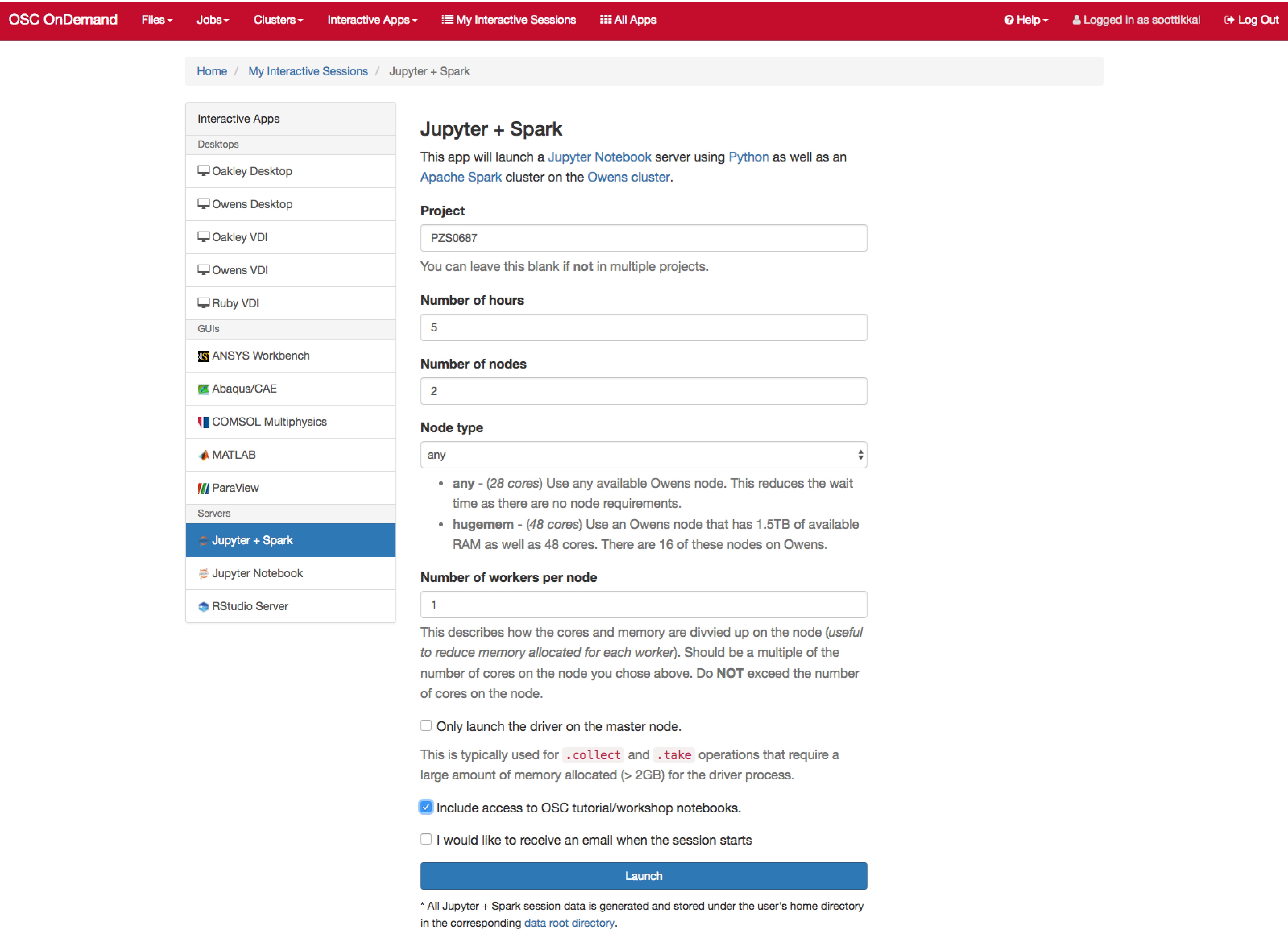
2017-05-04 - NEW SCRATCH FFECT JUNE 1

The new scratch storage policy will take We will shorten our file deletion period to 120 days. More information can be found here: http://bit.ly/2qFVh8v

2017-04-03 - GPUS NOW AVA

160 GPU nodes on Owens are available and now include the Nvidia P100. For more information on how to use the GPUs, check out our documentation page: http://bit.ly/2ouDOSV

Please contact oschelp@osc.edu if you have any questions.



Jupyter + Spark

This app will launch a Jupyter Notebook server using Python as well as an Apache Spark cluster on the Owens cluster.

Project

PZS0687

You can leave this blank if **not** in multiple projects.

Number of hours

5

Number of nodes

2

Node type

any

- **any** - (*28 cores*) Use any available Owens node. This reduces the wait time as there are no node requirements.
- **hugemem** - (*48 cores*) Use an Owens node that has 1.5TB of available RAM as well as 48 cores. There are 16 of these nodes on Owens.

Number of workers per node

1

This describes how the cores and memory are divvied up on the node (*useful to reduce memory allocated for each worker*). Should be a multiple of the number of cores on the node you chose above. Do **NOT** exceed the number of cores on the node.

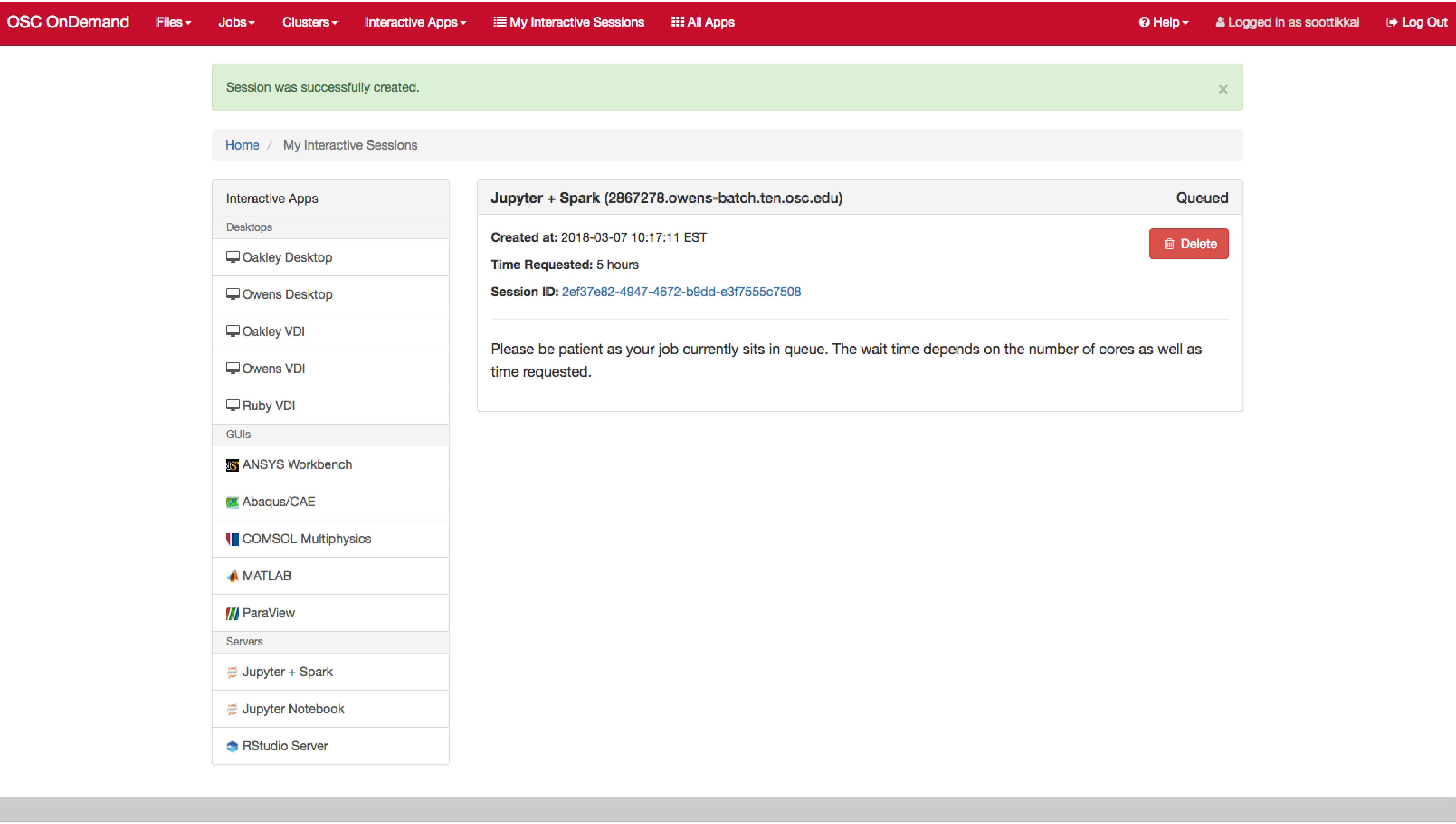
☐ Only launch the driver on the master node.

This is typically used for `.collect` and `.take` operations that require a large amount of memory allocated (> 2GB) for the driver process.

☑ Include access to OSC tutorial/workshop notebooks.

☐ I would like to receive an email when the session starts

* All Jupyter + Spark session data is generated and stored under the user's home directory in the corresponding data root directory.



Session was successfully created.

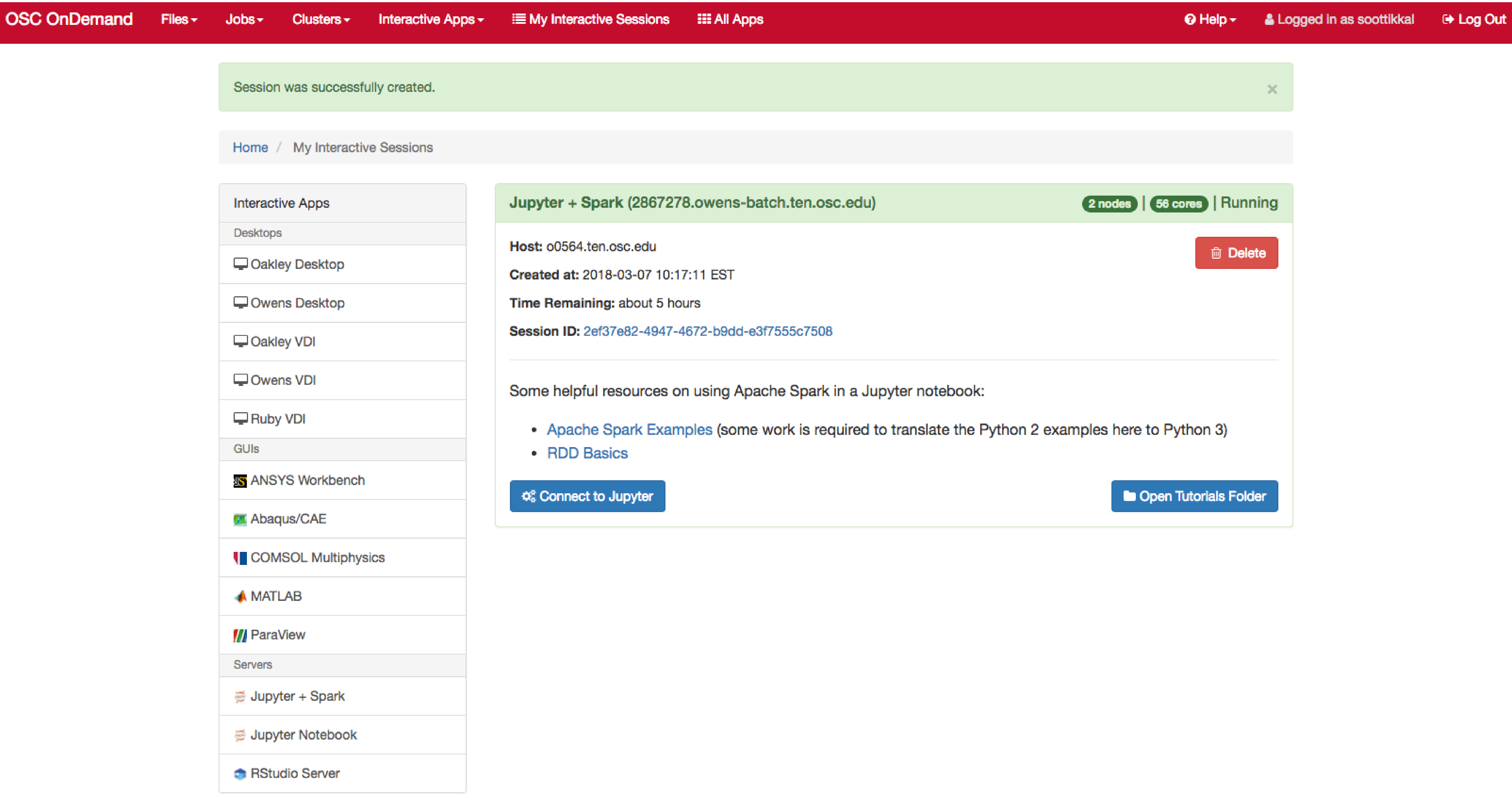
Jupyter + Spark (2867278.owens-batch.ten.osc.edu) **Queued**

Created at: 2018-03-07 10:17:11 EST

Time Requested: 5 hours

Session ID: 2ef37e82-4947-4672-b9dd-e3f7555c7508

Please be patient as your job currently sits in queue. The wait time depends on the number of cores as well as time requested.



Session was successfully created.

Jupyter + Spark (2867278.owens-batch.ten.osc.edu) | 2 nodes | 56 cores | Running

Host: o0564.ten.osc.edu

Created at: 2018-03-07 10:17:11 EST

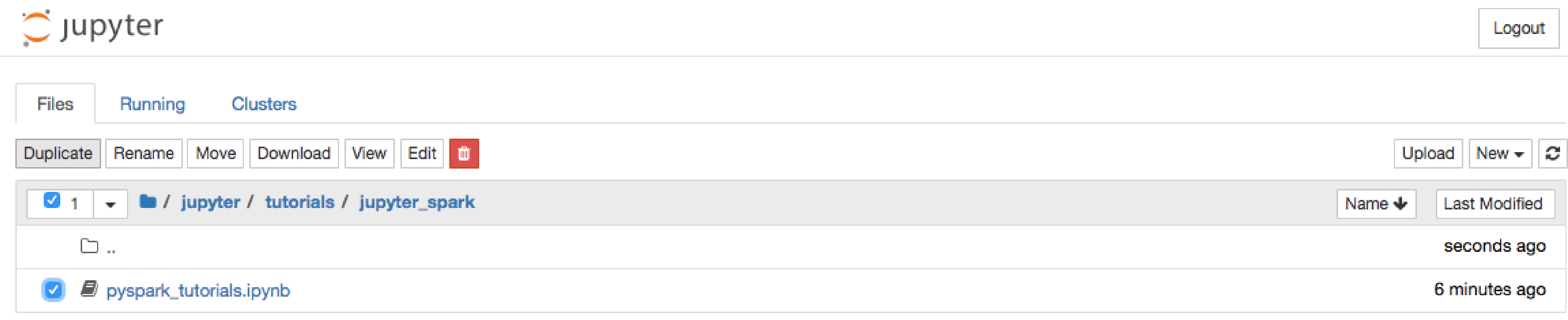
Time Remaining: about 5 hours

Session ID: 2ef37e82-4947-4672-b9dd-e3f7555c7508

Some helpful resources on using Apache Spark in a Jupyter notebook:

- Apache Spark Examples (some work is required to translate the Python 2 examples here to Python 3)
- RDD Basics

You will see a file called pyspark_tutorials.ipynb. Please check on the file and click on duplicate to make a copy of the file.

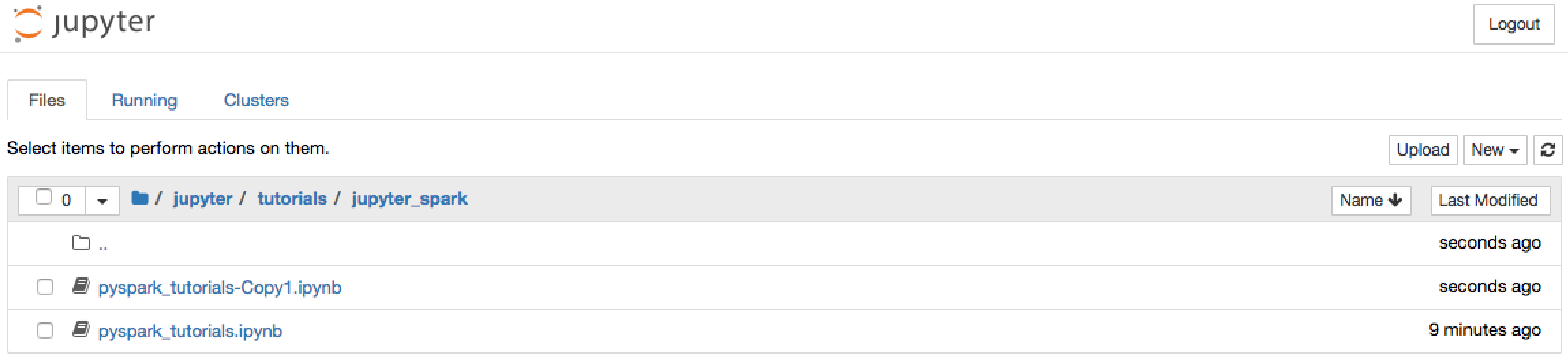


☑ 1 / jupyter / tutorials / jupyter_spark

.. seconds ago

☑ pyspark_tutorials.ipynb 6 minutes ago

You will see a new file pyspark_tutorials-Copy1.ipynb is created. Double-click on the pyspark_tutorials-Copy1.ipynb file will launch Jupyter interface for Spark to proceed with the tutorials.



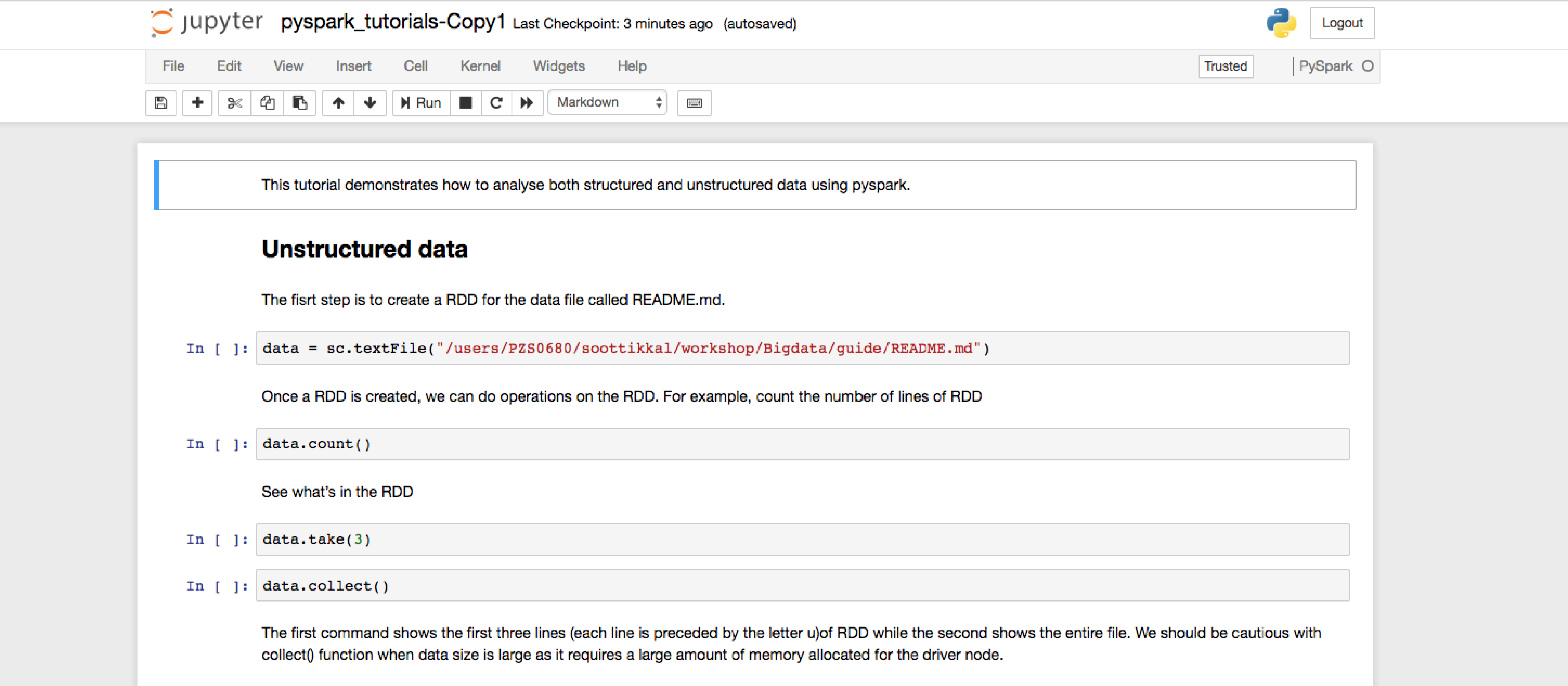
Select items to perform actions on them.

□ 0 / jupyter / tutorials / jupyter_spark

.. seconds ago

□ pyspark_tutorials-Copy1.ipynb seconds ago

□ pyspark_tutorials.ipynb 9 minutes ago



This tutorial demonstrates how to analyse both structured and unstructured data using pyspark.

Unstructured data

The fisrt step is to create a RDD for the data file called README.md.

```
In [ ]: data = sc.textFile("/users/PZS0680/soottikkal/workshop/Bigdata/guide/README.md")
```

Once a RDD is created, we can do operations on the RDD. For example, count the number of lines of RDD

```
In [ ]: data.count()
```

See what's in the RDD

```
In [ ]: data.take(3)
```

```
In [ ]: data.collect()
```

The first command shows the first three lines (each line is preceded by the letter u)of RDD while the second shows the entire file. We should be cautious with collect() function when data size is large as it requires a large amount of memory allocated for the driver node.

Running Spark interactively in batch

To run Spark interactively, but in batch on Owens please run the following command,

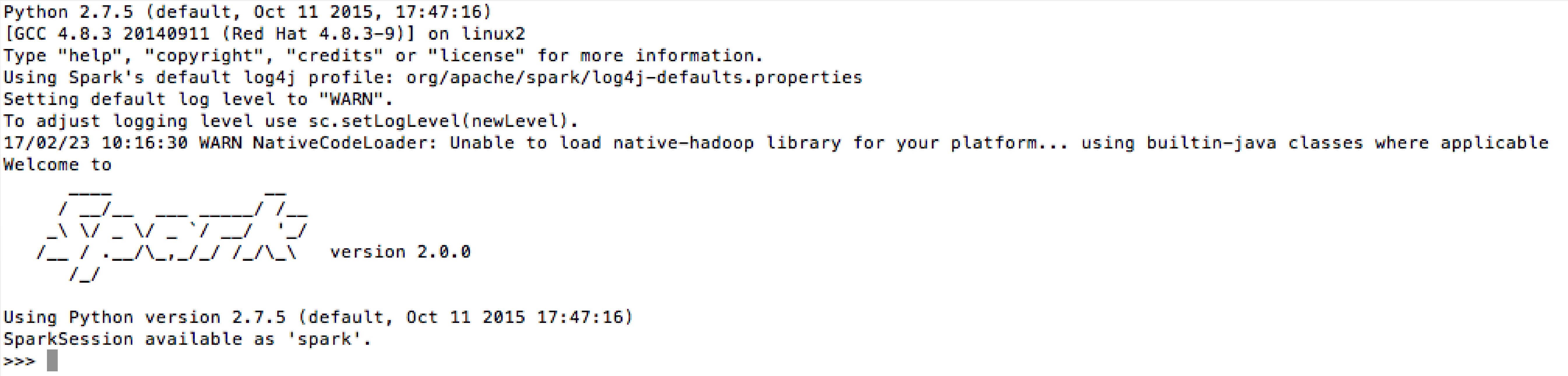
```
qsub -I -l nodes=4:ppn=28 -l walltime=01:00:00
```

When your interactive shell is ready, please launch spark cluster using the pbs-spark-submit script

```
pbs-spark-submit
```

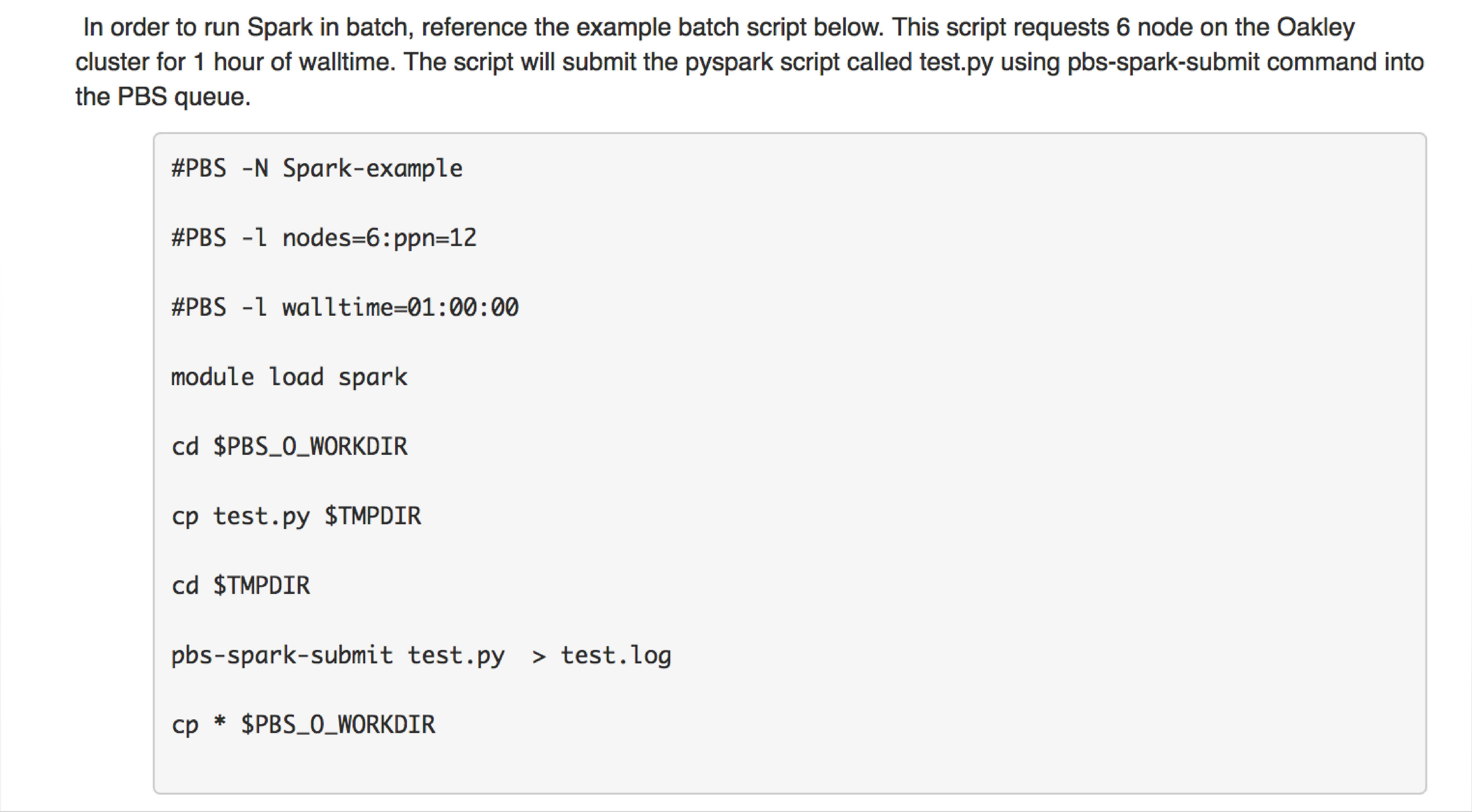
You can then launch the interface for pyspark as follows,

```
pyspark --master spark://nodename.ten.osc.edu:7070
```



```
Python 2.7.5 (default, Oct 11 2015, 17:47:16)
[GCC 4.8.3 20140911 (Red Hat 4.8.3-9)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
Using Spark's default log4j profile: org/apache/spark/log4j-defaults.properties
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel).
17/02/23 10:16:30 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 2.0.0
      /_/

Using Python version 2.7.5 (default, Oct 11 2015 17:47:16)
SparkSession available as 'spark'.
>>>
```

Running Spark non-interactively



In order to run Spark in batch, reference the example batch script below. This script requests 6 node on the Oakley cluster for 1 hour of walltime. The script will submit the pyspark script called test.py using pbs-spark-submit command into the PBS queue.

```
#PBS -N Spark-example

#PBS -l nodes=6:ppn=12

#PBS -l walltime=01:00:00

module load spark

cd $PBS_O_WORKDIR

cp test.py $TMPDIR

cd $TMPDIR

pbs-spark-submit test.py  > test.log

cp * $PBS_O_WORKDIR
```

Running Spark using PBS script

1. Create an App in python: stati.py

```
from pyspark import SparkContext
import urllib
f = urllib.urlretrieve ("http://kdd.ics.uci.edu/databases/kddcup99/kddcup.data.gz","kddcup.data.gz")

data_file = "./kddcup.data.gz"
sc = SparkContext(appName="Stati")
raw_data = sc.textFile(data_file)

import numpy as np

def parse_interaction(line):
    line_split = line.split(",")
    symbolic_indexes = [1,2,3,41]
    clean_line_split=[item for i, item in enumerate(line_split) if i not in symbolic_indexes]
    return np.array([float(x) for x in clean_line_split])

vector_data=raw_data.map(parse_interaction)


from pyspark.mllib.stat import Statistics
from math import sqrt

summary = Statistics.colStats(vector_data)


print ("Duration Statistics:")
print (" Mean %f" % (round(summary.mean()[0],3)))
print ("St. deviation : %f"%(round(sqrt(summary.variance()[0]),3)))
print (" Max value: %f"%(round(summary.max()[0],3)))
print (" Min value: %f"%(round(summary.min()[0],3)))
```

2. Create a PBS script: stati.pbs

```
#PBS -N spark-statistics
#PBS -l nodes=18:ppn=28
#PBS -l walltime=00:10:00
module load spark/2.0.0
cp stati.py $TMPDIR
cd $TMPDIR
pbs-spark-submit stati.py > stati.log
cp *  $PBS_O_WORKDIR
```

3. Run Spark job

```
qsub stati.pbs
```

4. Output: stati.log

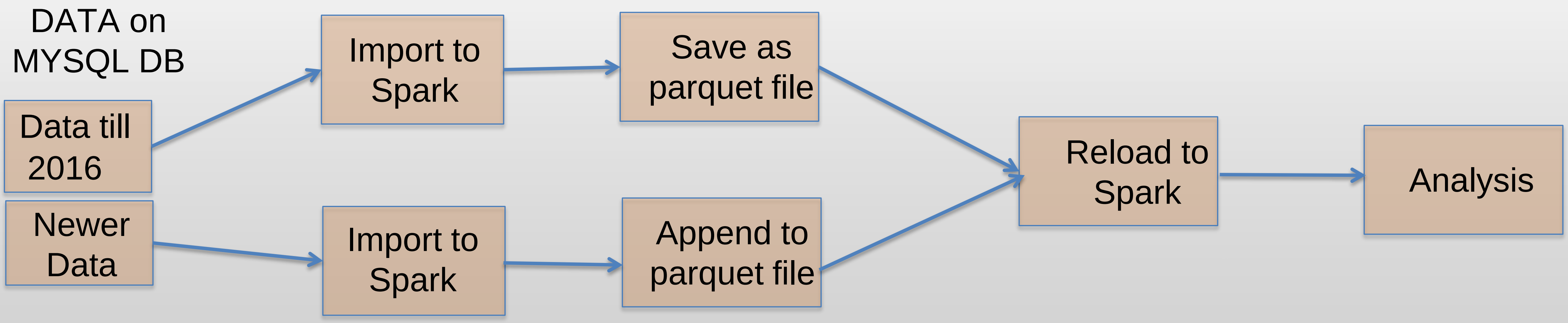
```
sync from spark://n0381.ten.osc.edu:7077
starting org.apache.spark.deploy.master.Master, logging to /nfs/15/soottikkal/spark/kdd/spark-soottikkal-
org.apache.spark.deploy.master.Master-1-n0381.ten.osc.edu.out
failed to launch org.apache.spark.deploy.master.Master:
full log in /nfs/15/soottikkal/spark/kdd/spark-soottikkal-org.apache.spark.deploy.master.Master-1-n0381.ten.osc.edu.out

Duration Statistics:
Mean 48.342000
St. deviation : 723.330000
Max value: 58329.000000
Min value: 0.000000
Total value count: 4898431.000000
Number of non-zero values: 118939.000000


SPARK_MASTER=spark://n0381.ten.osc.edu:7077
```

CASE STUDY

Data mining of historical jobs records of OSC's clusters

Aim: To understand client utilizations of OSC recourses.

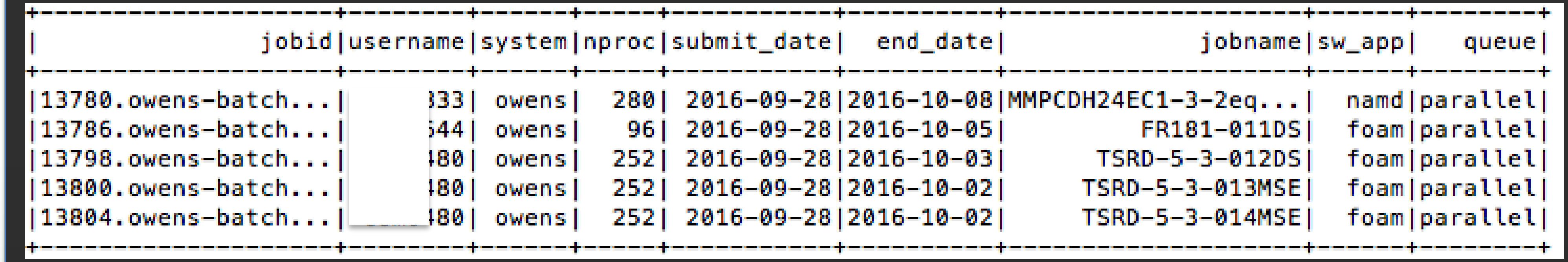
Data: Historical records of every Job that ran on any OSC clusters that includes information's such as number of nodes, software, CPU time and timestamp.



Pyspark code for data analysis

#importing data

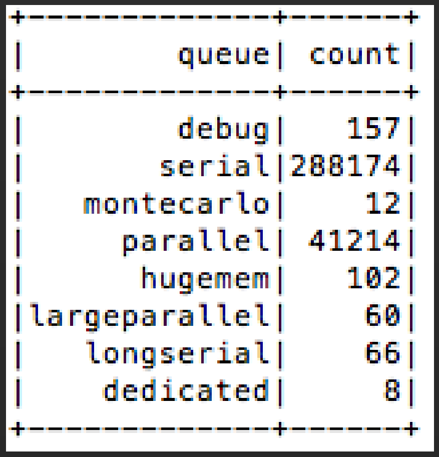
```
df=sqlContext.read.parquet(“pbsacct/Jobs.parquet")
df.show(5)
```



```
+--------------------+--------+------+-----+-----------+----------+--------------------+------+---------+
|               jobid|username|system|nproc|submit_date|  end_date|             jobname|sw_app|    queue|
+--------------------+--------+------+-----+-----------+----------+--------------------+------+---------+
|13780.owens-batch...|[redacted]| owens|  280| 2016-09-28|2016-10-08|MMPCDH24EC1-3-2eq...|  namd|parallel|
|13786.owens-batch...|[redacted]| owens|   96| 2016-09-28|2016-10-05|          FR181-011DS|  foam|parallel|
|13798.owens-batch...|[redacted]| owens|  252| 2016-09-28|2016-10-03|        TSRD-5-3-012DS|  foam|parallel|
|13800.owens-batch...|[redacted]| owens|  252| 2016-09-28|2016-10-02|       TSRD-5-3-013MSE|  foam|parallel|
|13804.owens-batch...|[redacted]| owens|  252| 2016-09-28|2016-10-02|       TSRD-5-3-014MSE|  foam|parallel|
+--------------------+--------+------+-----+-----------+----------+--------------------+------+---------+
```

#Which types of queue is mostly used

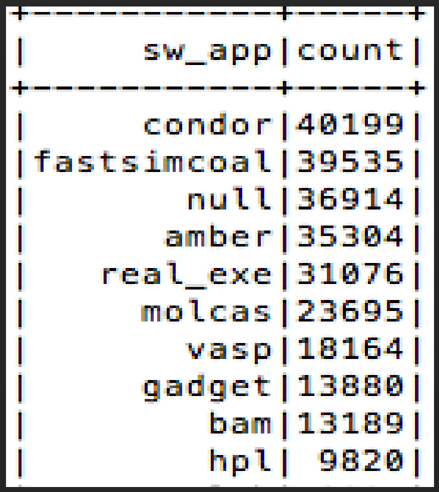
```
df.select("jobid",”queue").groupBy("queue").count().show()
```



```
+-------------+------+
|        queue| count|
+-------------+------+
|        debug|   157|
|       serial|288174|
|   montecarlo|    12|
|     parallel| 41214|
|      hugemem|   102|
|largeparallel|    60|
|   longserial|    66|
|    dedicated|     8|
+-------------+------+
```

#Which software is used most?

```
df.select("jobid","sw_app").groupBy
("sw_app").count().sort(col("count").desc()) .show()
```



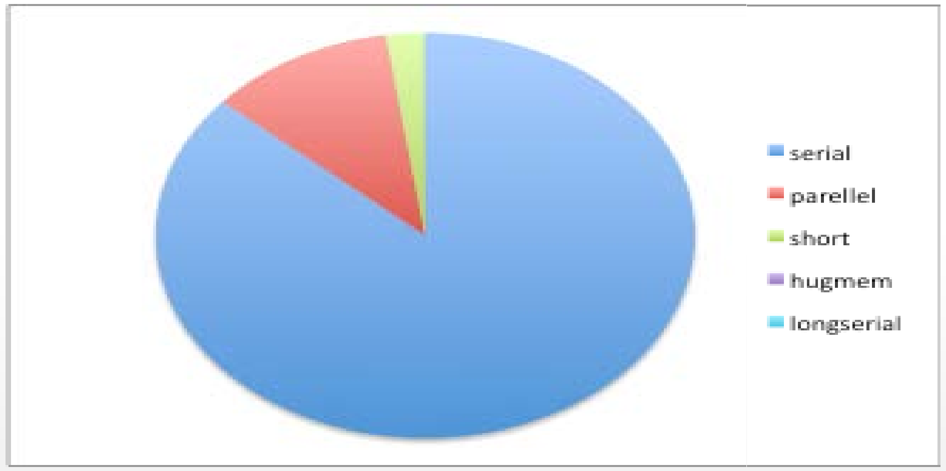
```
+-----------+-----+
|     sw_app|count|
+-----------+-----+
|     condor|40199|
|fastsimcoal|39535|
|       null|36914|
|      amber|35304|
|   real_exe|31076|
|     molcas|23695|
|       vasp|18164|
|     gadget|13880|
|        bam|13189|
|        hpl| 9820|
```

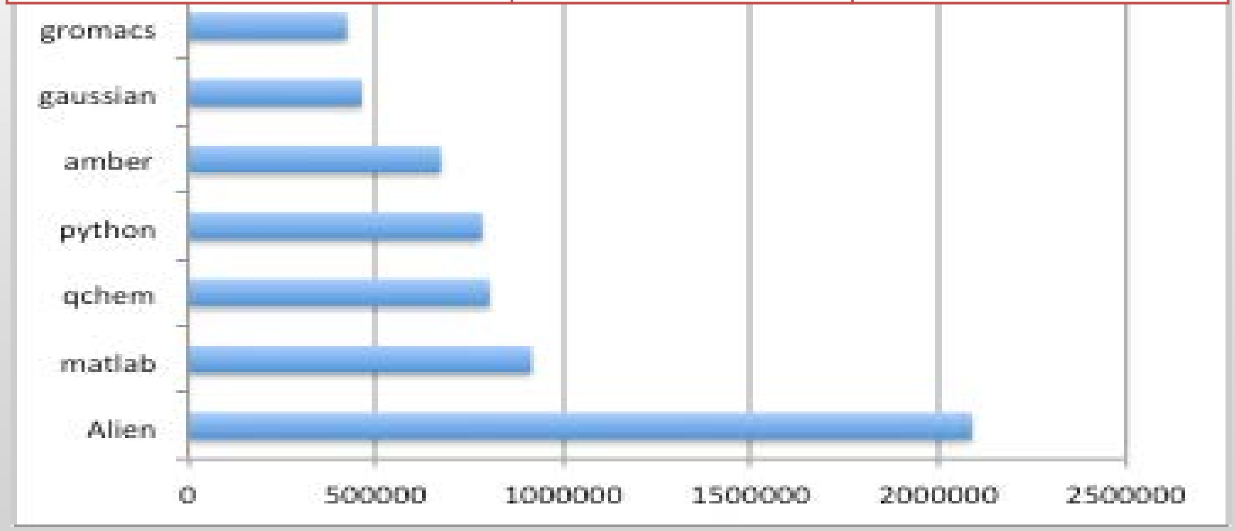
#who uses gaussian software most?

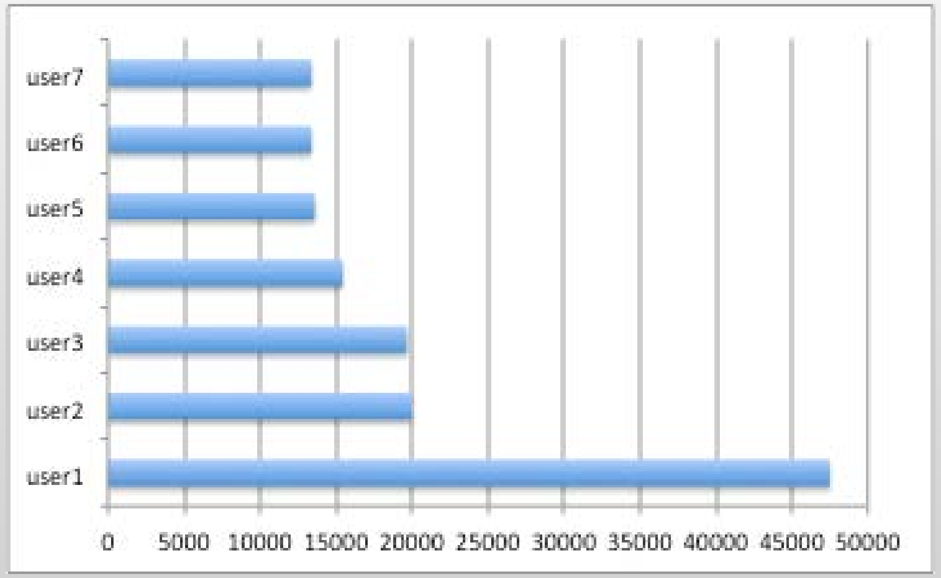
```
df.registerTempTable(”Jobs”)
sqlContext.sql(" SELECT username FROM
Jobs WHERE sw_app='gaussian’ " ).show()
```

Results

Statistics	MYSQL	SPARK
Job vs CPU	1 hour	5 sec
CPU vs Account	1.25 hour	5 sec
Walltime vs user	1.40 hour	5 sec

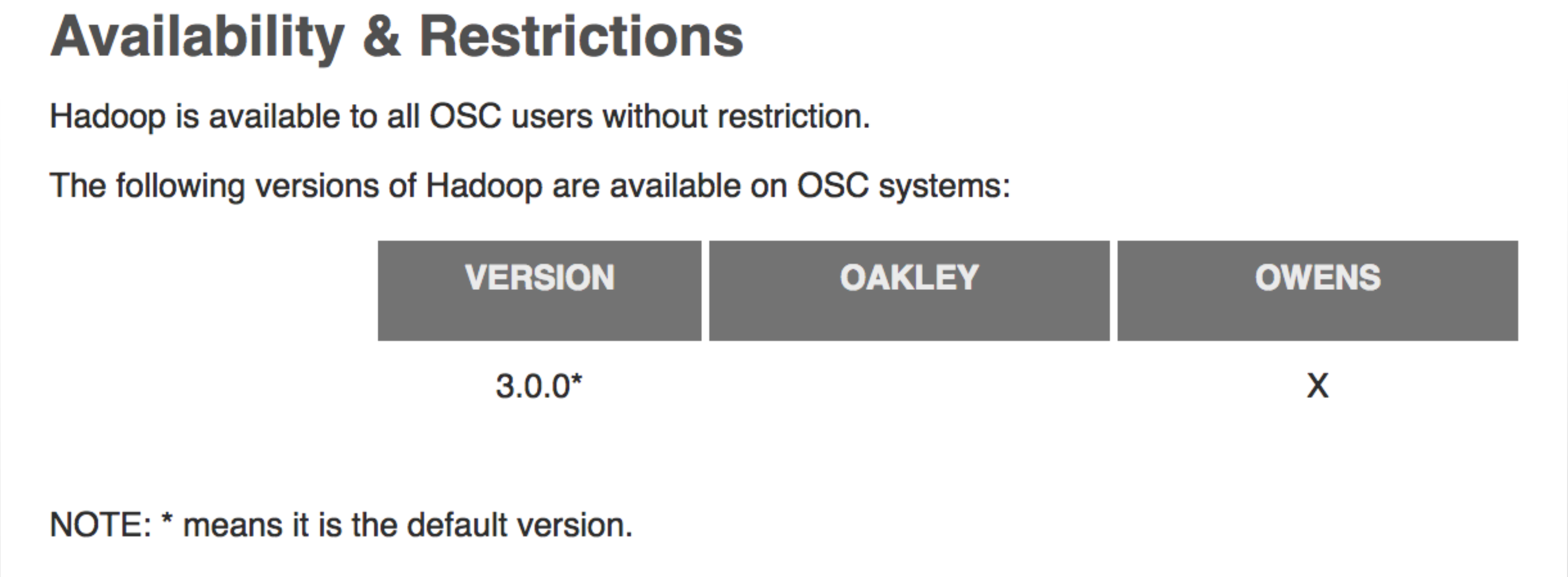






Running Hadoop at OSC

A Hadoop cluster can be launched within the HPC environment, but managed by the PBS job scheduler using Myhadoop framework developed by San Diego Supercomputer Center. (Please see http://www.sdsc.edu/~allans/MyHadoop.pdf)



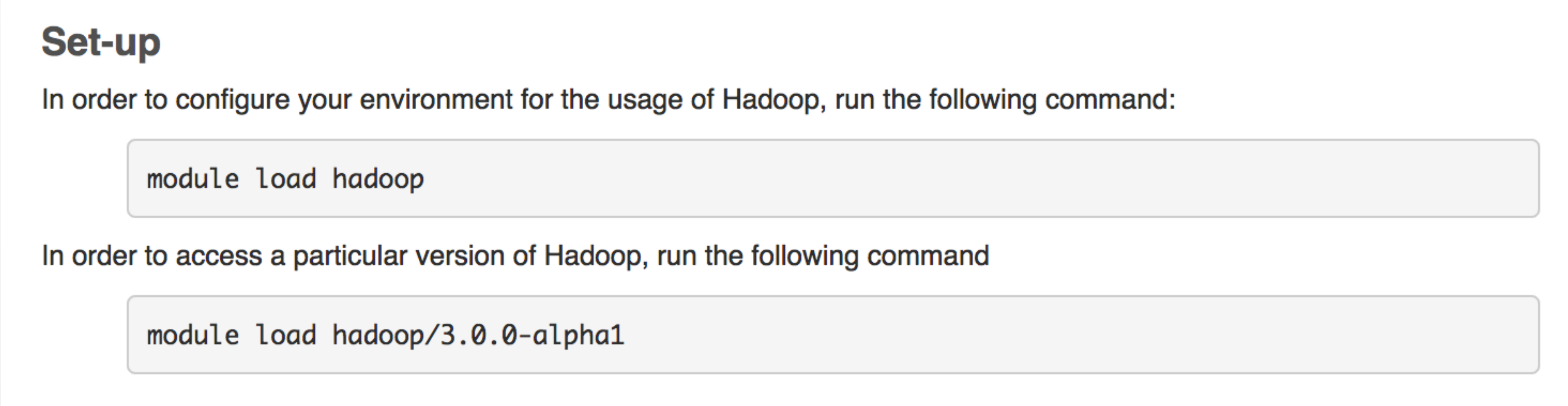
Availability & Restrictions

Hadoop is available to all OSC users without restriction.

The following versions of Hadoop are available on OSC systems:

VERSION	OAKLEY	OWENS
3.0.0*		X

NOTE: * means it is the default version.



Set-up

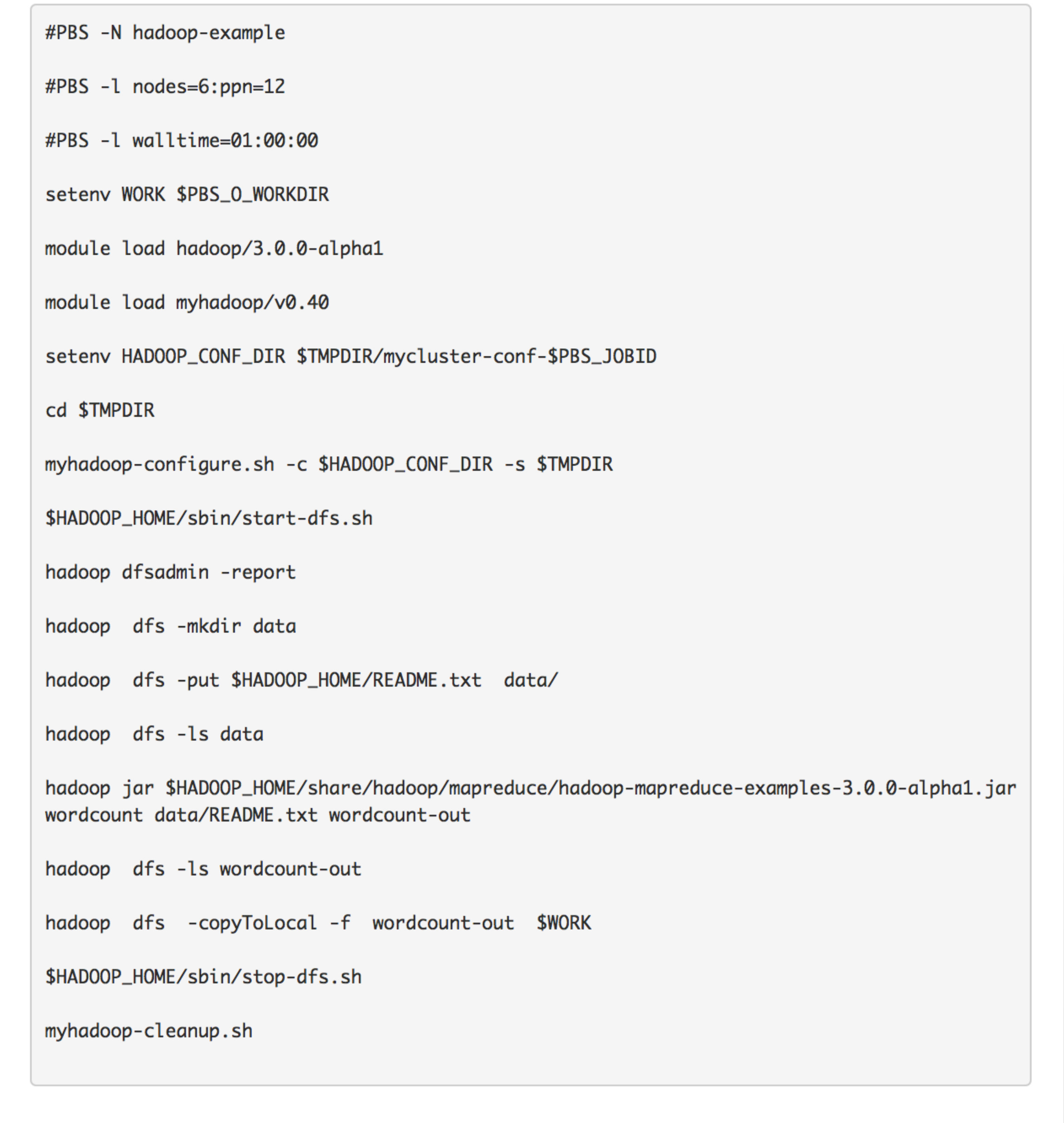
In order to configure your environment for the usage of Hadoop, run the following command:

```
module load hadoop
```

In order to access a particular version of Hadoop, run the following command

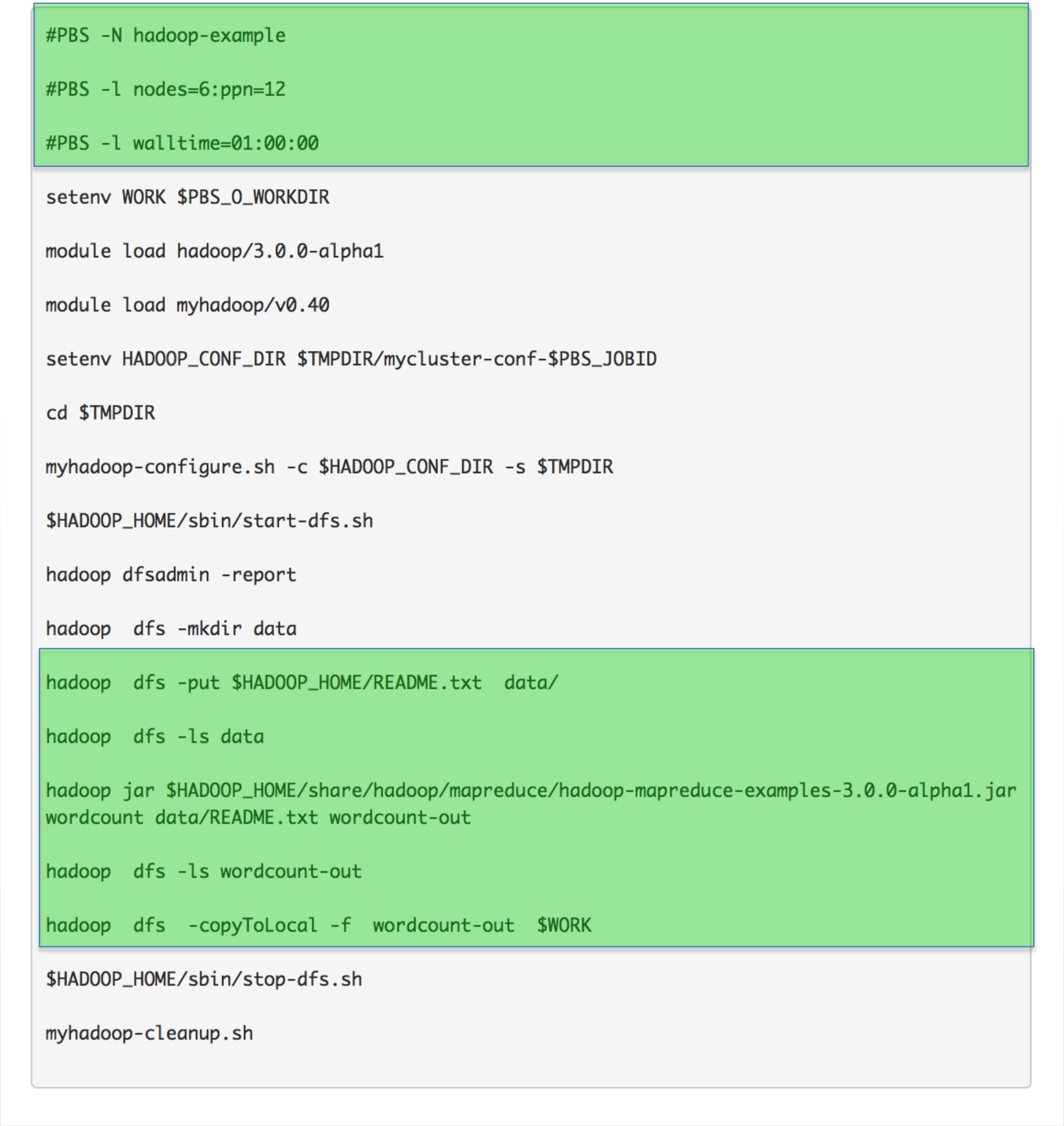
```
module load hadoop/3.0.0-alpha1
```

Using Hadoop: Sample PBS Script



```
#PBS -N hadoop-example

#PBS -l nodes=6:ppn=12

#PBS -l walltime=01:00:00

setenv WORK $PBS_O_WORKDIR

module load hadoop/3.0.0-alpha1

module load myhadoop/v0.40

setenv HADOOP_CONF_DIR $TMPDIR/mycluster-conf-$PBS_JOBID

cd $TMPDIR

myhadoop-configure.sh -c $HADOOP_CONF_DIR -s $TMPDIR

$HADOOP_HOME/sbin/start-dfs.sh

hadoop dfsadmin -report

hadoop  dfs -mkdir data

hadoop  dfs -put $HADOOP_HOME/README.txt  data/

hadoop  dfs -ls data

hadoop jar $HADOOP_HOME/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.0.0-alpha1.jar
wordcount data/README.txt wordcount-out

hadoop  dfs -ls wordcount-out

hadoop  dfs  -copyToLocal -f  wordcount-out  $WORK

$HADOOP_HOME/sbin/stop-dfs.sh

myhadoop-cleanup.sh
```

Using Hadoop: Sample PBS Script



```
#PBS -N hadoop-example

#PBS -l nodes=6:ppn=12

#PBS -l walltime=01:00:00

setenv WORK $PBS_O_WORKDIR

module load hadoop/3.0.0-alpha1

module load myhadoop/v0.40

setenv HADOOP_CONF_DIR $TMPDIR/mycluster-conf-$PBS_JOBID

cd $TMPDIR

myhadoop-configure.sh -c $HADOOP_CONF_DIR -s $TMPDIR

$HADOOP_HOME/sbin/start-dfs.sh

hadoop dfsadmin -report

hadoop  dfs -mkdir data

hadoop  dfs -put $HADOOP_HOME/README.txt  data/

hadoop  dfs -ls data

hadoop jar $HADOOP_HOME/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.0.0-alpha1.jar
wordcount data/README.txt wordcount-out

hadoop  dfs -ls wordcount-out

hadoop  dfs  -copyToLocal -f  wordcount-out  $WORK

$HADOOP_HOME/sbin/stop-dfs.sh

myhadoop-cleanup.sh
```

Upcoming Events

XSEDE Big Data workshop

May 1-2; 11-5 p.m.; Ohio Supercomputer Center, 1224 Kinnear Road.

OSC Big Data workshop

June 6th; 12.30-4.30p.m.; Ohio Supercomputer Center, 1224 Kinnear Road.

Thank you!

- Questions or comments: soottikkal@osc.edu
- General questions about OSC service: oschelp@osc.edu