Running Hadoop with Docker

Pseudo Distributed mode using a single Docker container

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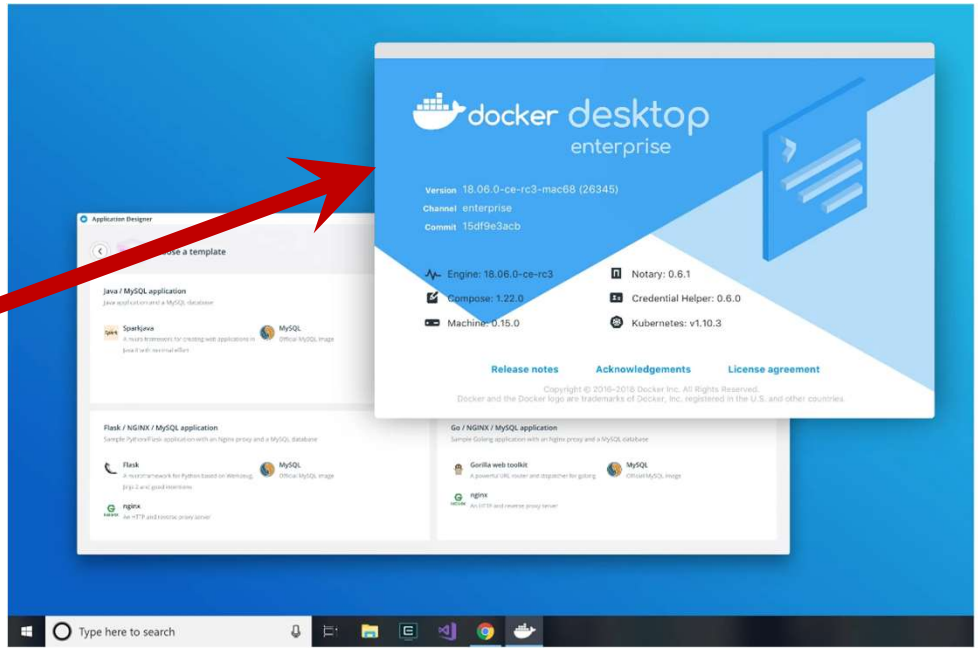
Environment Used

- Host environment
  - Windows
- Container environment
  - Docker Desktop
- SSH to interact with container



Steps

1 – Configuration

- Generate SSH keys
- Build Docker image
- Run container from image
- Install Hadoop

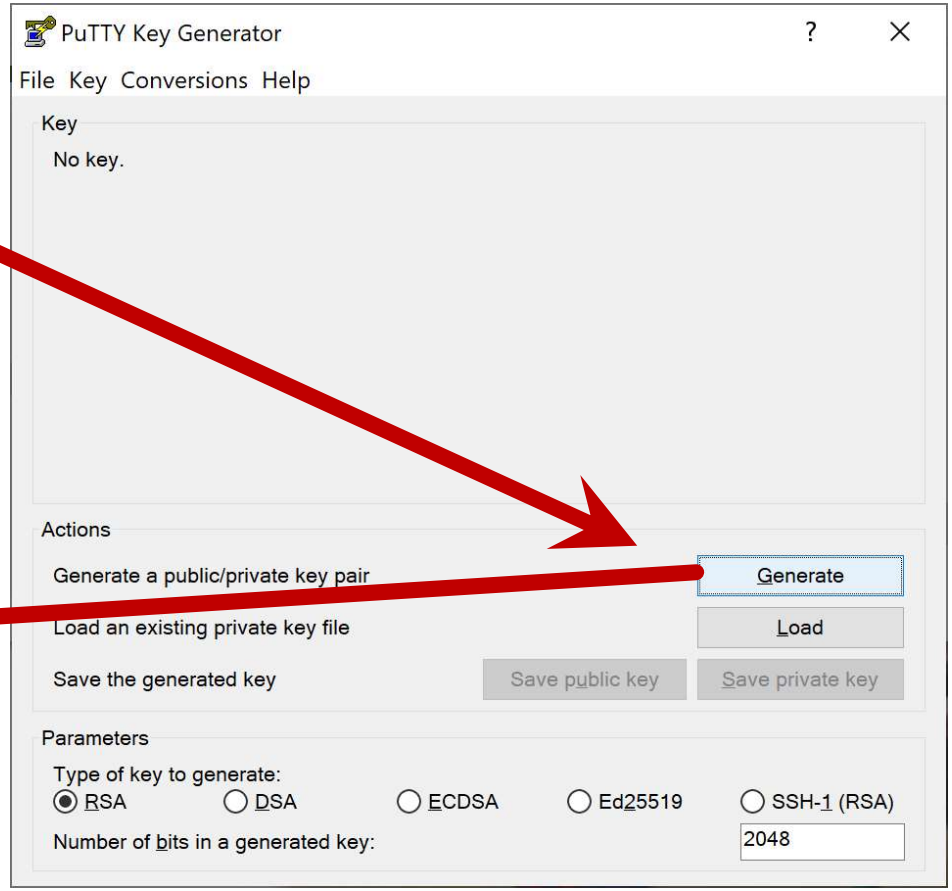
2 – Testing

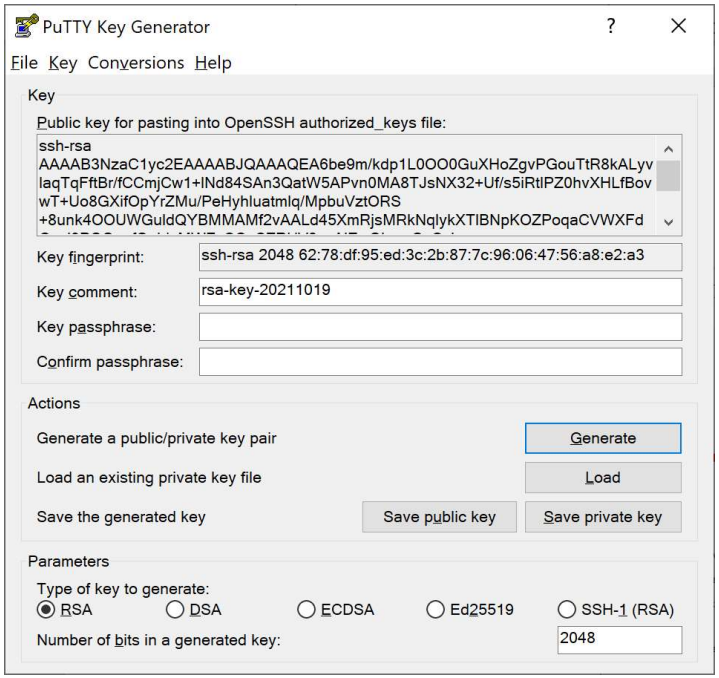
- Install examples
- Configure examples
- Build examples
- Run Word Count example

Configuration

Generate SSH keys

- Generate a public/private key pair using PuTTYgen





Configuration

Generate SSH keys

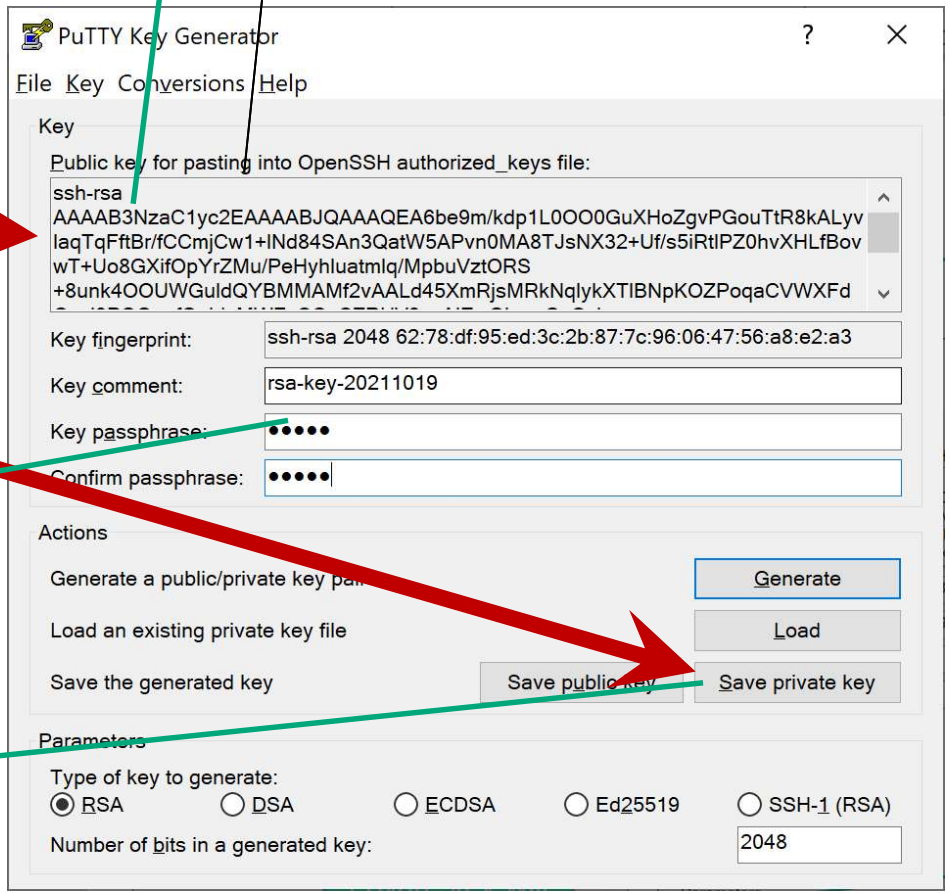
- Save both keys:
  - Public
  - Private

Public key will be later placed in the **authorized_keys** file

The same key can be used in different computers

Password to protect access to the private key

Private key will be managed by the PuTTY agent



Configuration

Files need to build Docker image

Definition for user aliases

Build Docker image

Run Docker container

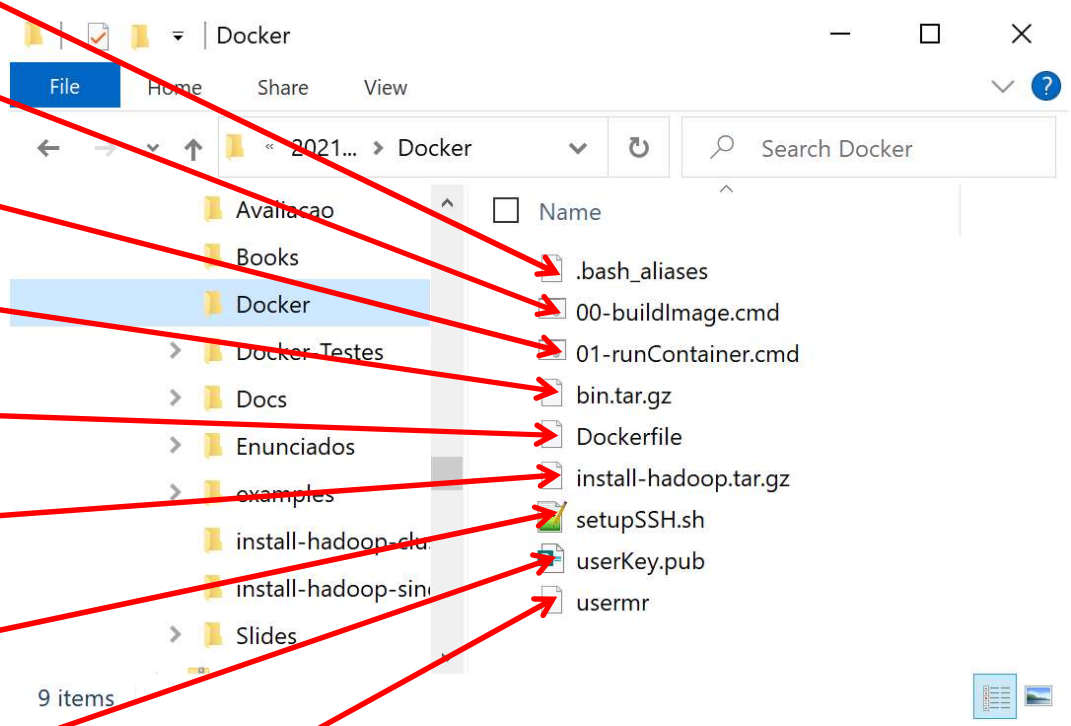
Scripts for the user **`bin`** directory

Docker file

Scripts used to install Hadoop

Scripts used to setup SSH in password less mode

SSH public key



Remove sudo password

Configuration

Build Docker image

Use the definitions contained in the file "Dockerfile"

- Execute script "`goBuildDocker.cmd`"

```
docker build -t cdle.ubuntu.2023.2024 .
```

```
C:\WINDOWS\system32\cmd.exe
docker build -t hadoop.ubuntu .
[+] Building 1.1s (2/3)
 => [internal] load build definition from Dockerfile                                    0.0s
 => => transferring dockerfile: 32B                                                     0.0s
 => [internal] load .dockerignore                                                       0.0s
 => => transferring context: 2B                                                         0.0s
 => [internal] load metadata for docker.io/library/ubuntu:latest                        1.0s
```

```
 => exporting to image                                                                  0.1s
 => => exporting layers                                                                 0.0s
 => => writing image sha256:acc07cf8bb72730f75d5eba4dbe5f84c26d6ba5c1c6f841ae7355a5c719000c7   0.0s
 => => naming to docker.io/library/hadoop.ubuntu                                        0.0s

Use 'docker scan' to run Snyk tests against images to find vulnerabilities and learn how to fix them
Press any key to continue . . .
```

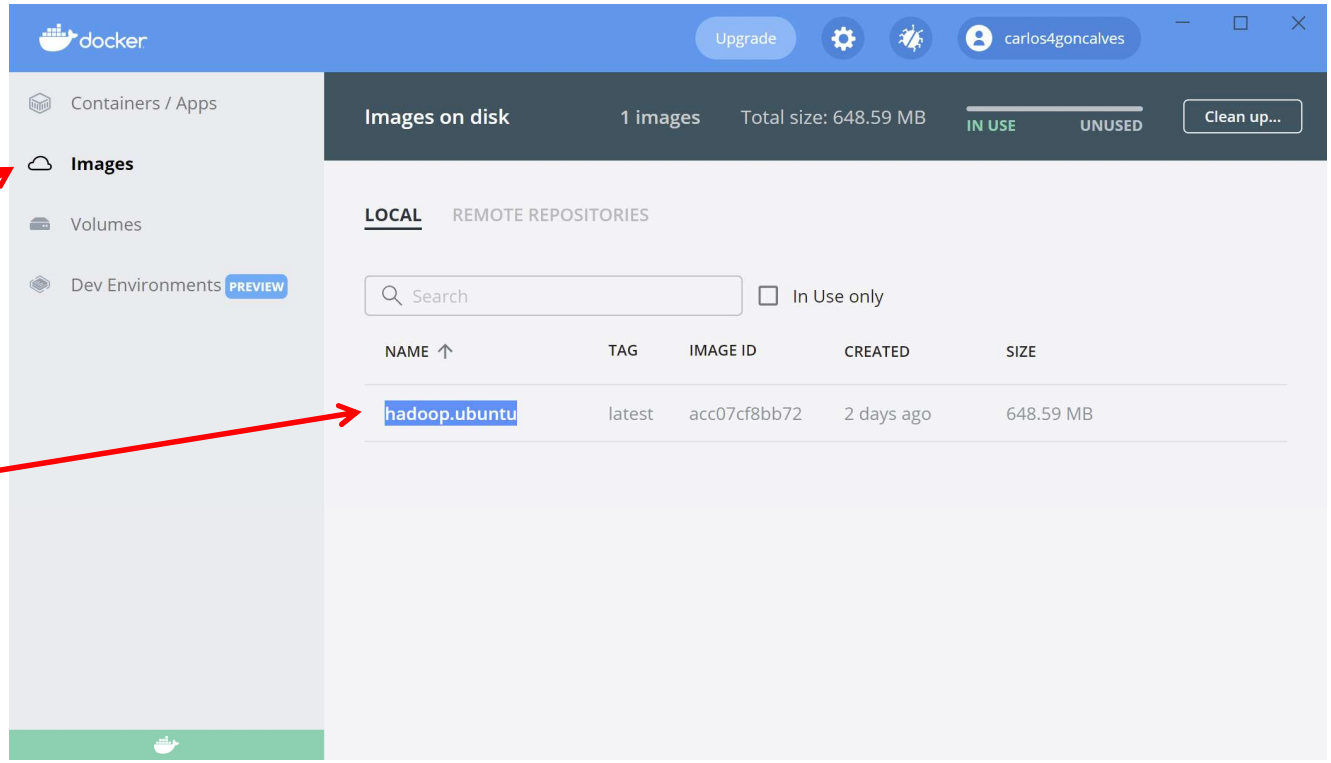
Configuration

Build Docker image

```
docker compose -f docker-compose-23-24.yml -p cdle-23-24 up -d
```

Existing images

Created image

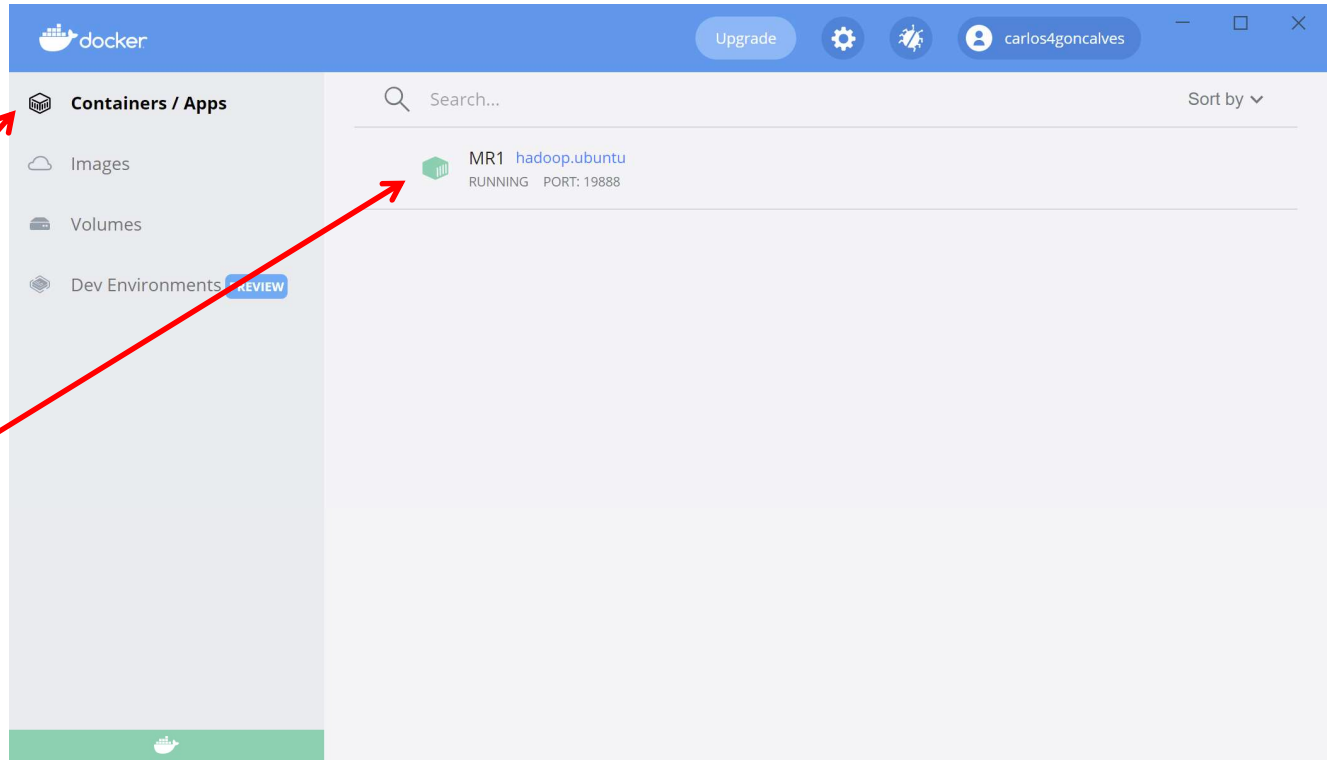


Configuration

Run container from image

Existing containers

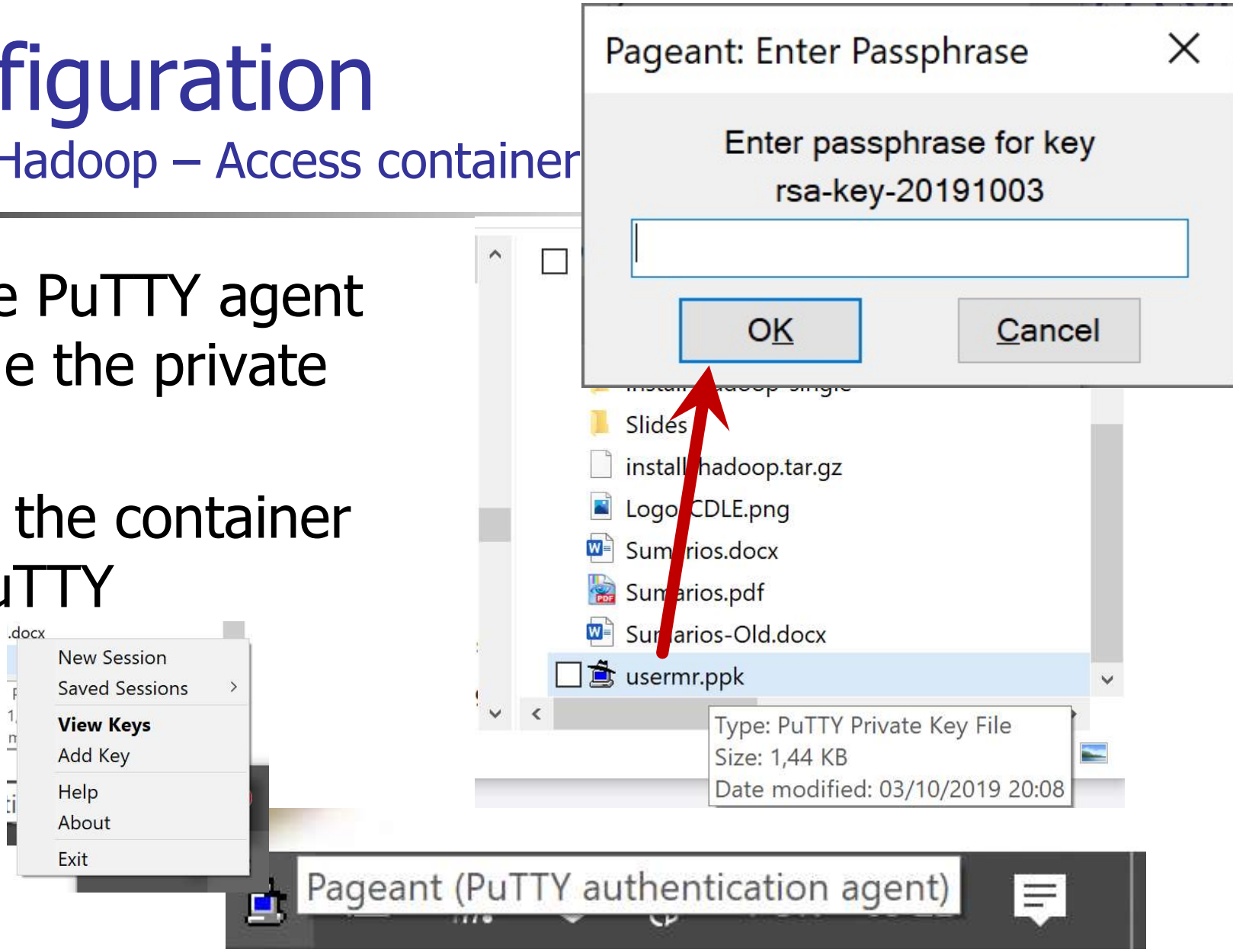
Created container



Configuration

Install Hadoop – Access container

- Start the PuTTY agent to handle the private keys
- Login in the container using PuTTY



Configuration

Install Hadoop – Access container

- The SSH server inside the container is available in port 22

- In the host this port is mapped onto port 222

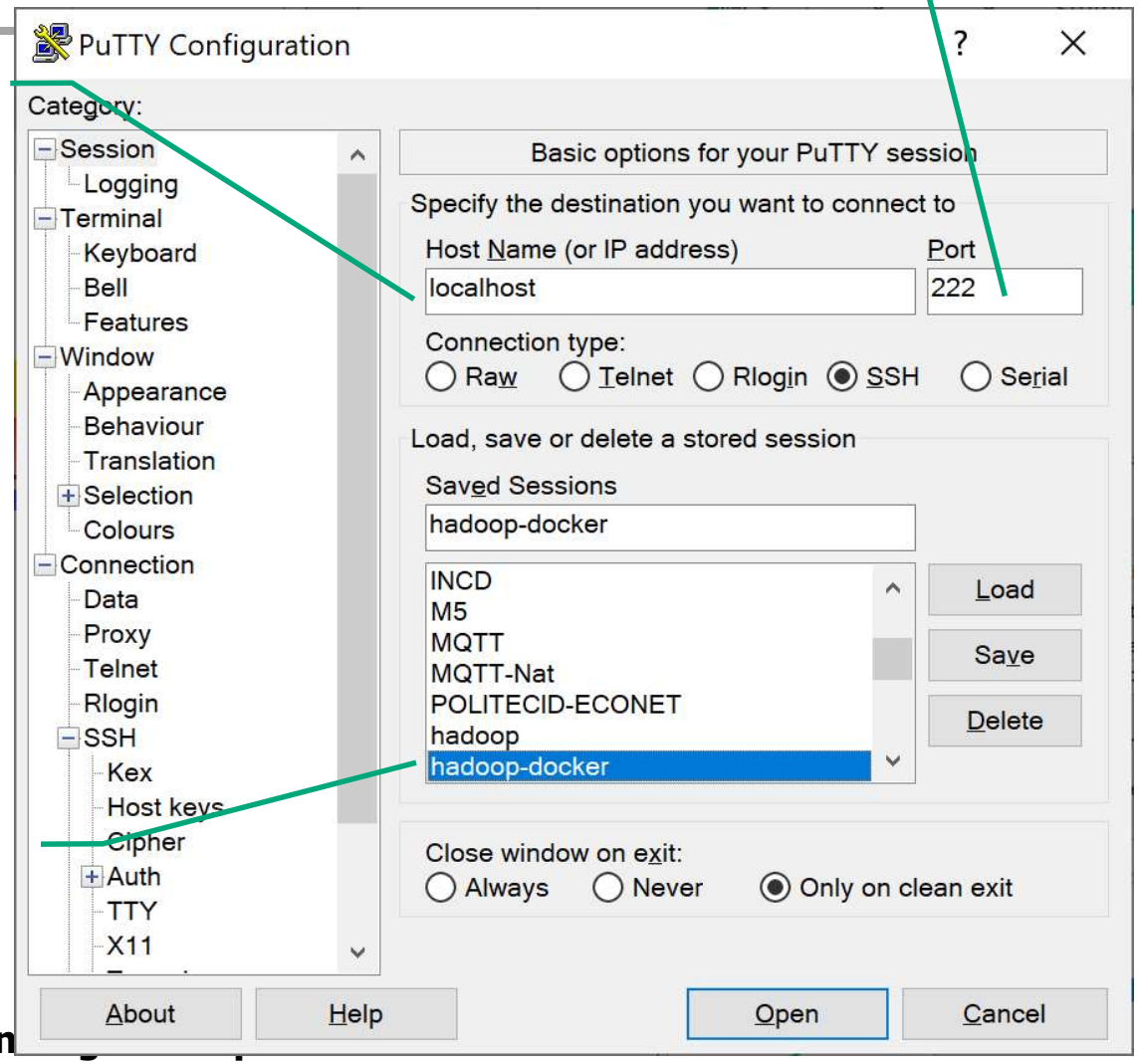
```
C:\WINDOWS\system32\cmd.exe
docker run --hostname hadoop --name MR1 --detach -p 222:22 -p
9888 hadoop.ubuntu
```

Configuration

Install Hadoop – Access container

Server port

Server address



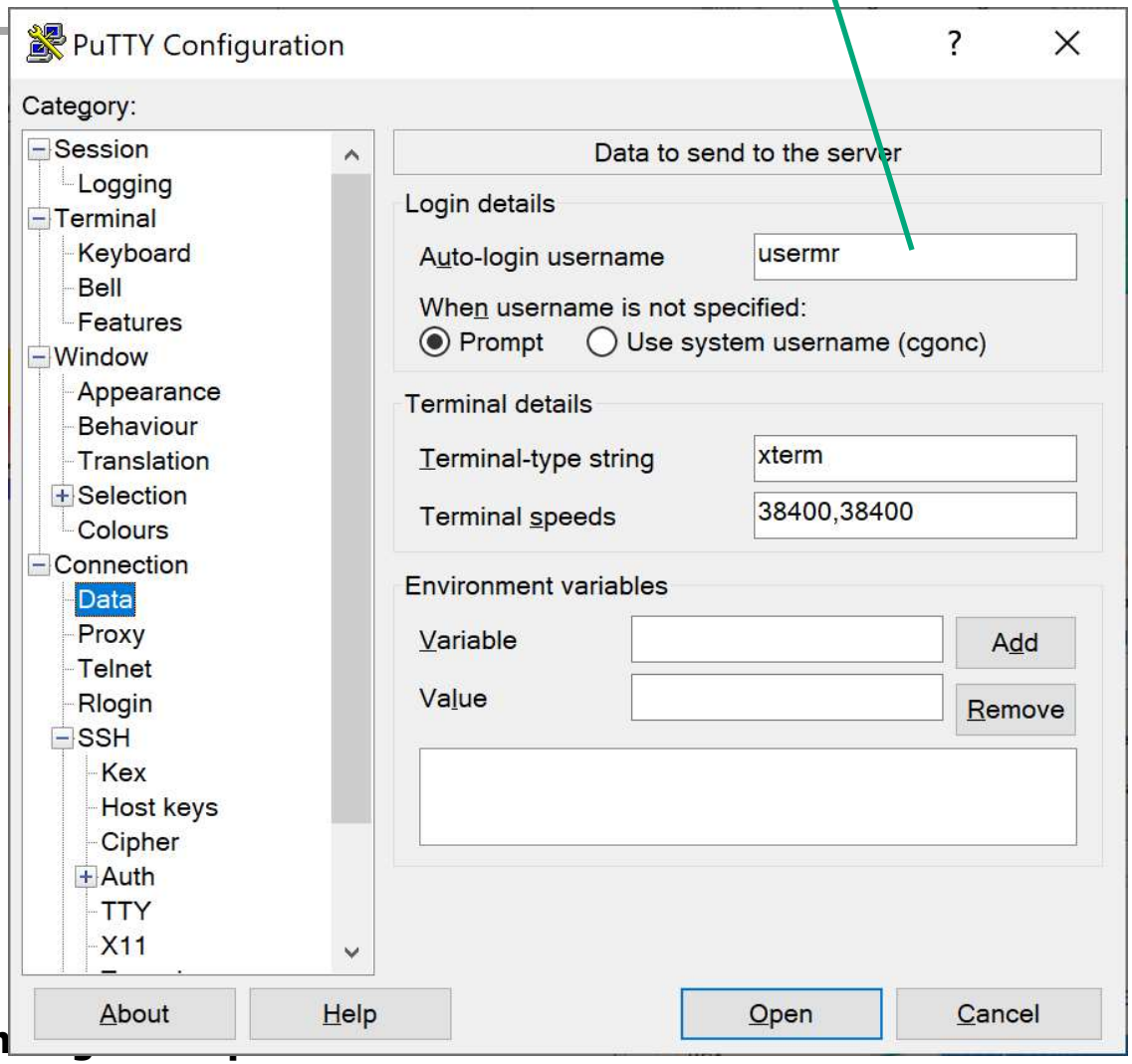
Session name

Run

Configuration

Install Hadoop – Access container

Auto login user name



Run

Configuration

Install Hadoop – Access container

```
usermr@hadoop: ~
Authenticating with public key "rsa-key-20191003" from agent
Welcome to Ubuntu 20.04.3 LTS (GNU/Linux 5.10.16.3-microsoft-standard-WSL2 x86_6
4)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

usermr@hadoop:~$
```

Configuration

Install Hadoop

- Steps sequence
  1. Start a SSH session
     - Execute script "`00-a-java-install.sh`"
  2. Start a SSH session
     - Execute script "`00-b-ant-install.sh`"
  3. Start a new session
     - Execute script "`00-c-maven-install.sh`"
  4. Start a new session
     - Execute script "`00-d-ssh-env.sh`"
  5. Start a new session
     - Execute script "`installHadoop.sh`"
  6. Start a new session
     - Execute script "`11-hadoop-InitUser.sh usermr`"

Configuration

Install Hadoop – Verify installation

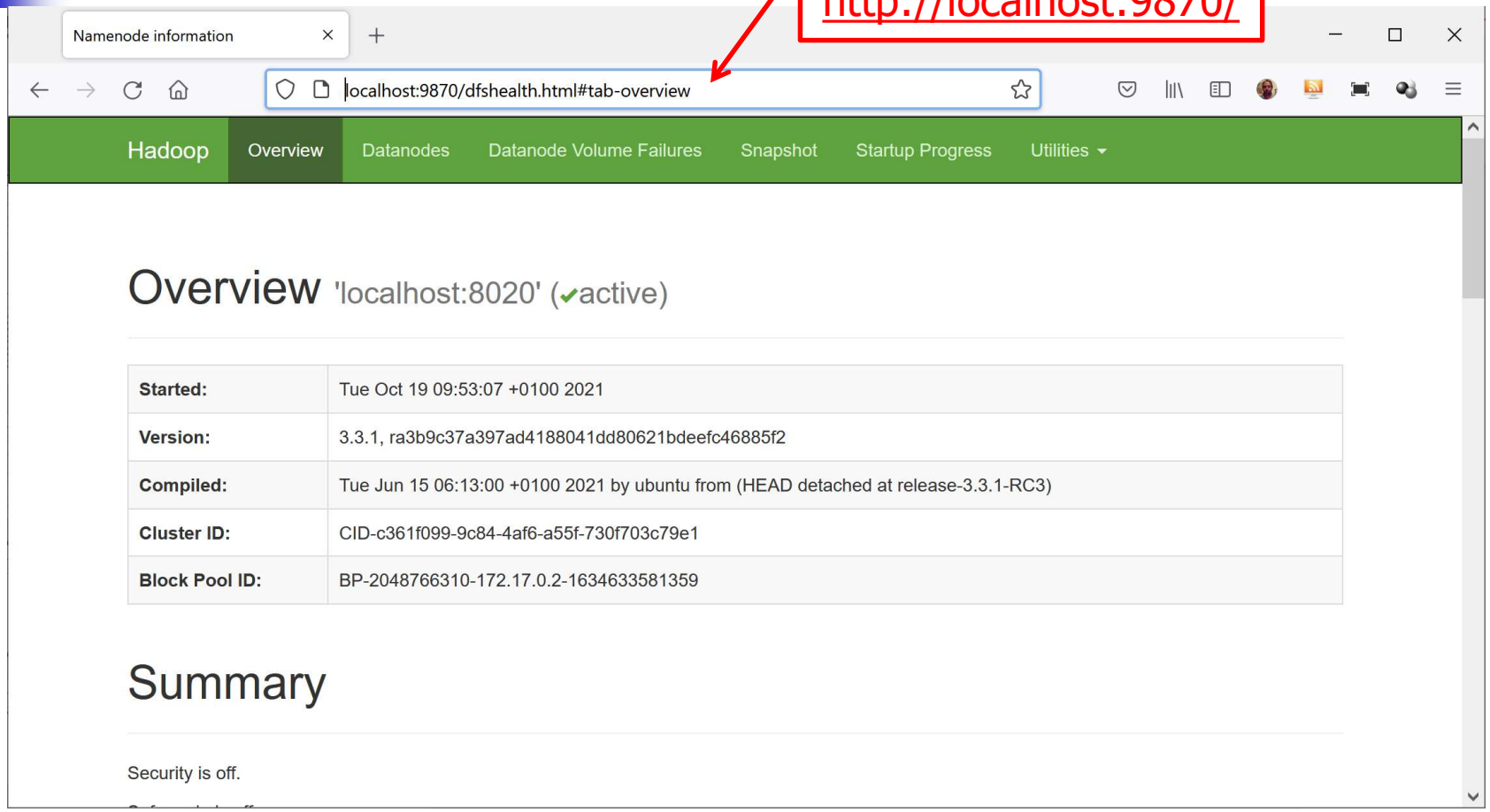
usermr@hadoop: ~

```
doop/bin/hadoop fs -chmod -R 0777 /user/history""
sshpass -p hdfs ssh -o StrictHostKeyChecking=no hdfs@localhost ""/work/hadoop/ha
doop/bin/hadoop fs -chown hadoop:hadoop /user/history""

Web UI is available at:

For the HDFS service (Name node):
http://localhost:9870/

For the HDFS service (Secondary name node):
http://localhost:9868/

For the HDFS service (Data nodes):
http://localhost:9864/

For the MapReduce service:
http://localhost:19888/

For the YARN service (Resource Manager):
http://localhost:8088/

For the YARN service (Nodes Manager):
http://localhost:8042/
usermr@hadoop:~$
```

Configuration

Install Hadoop – Verify installation

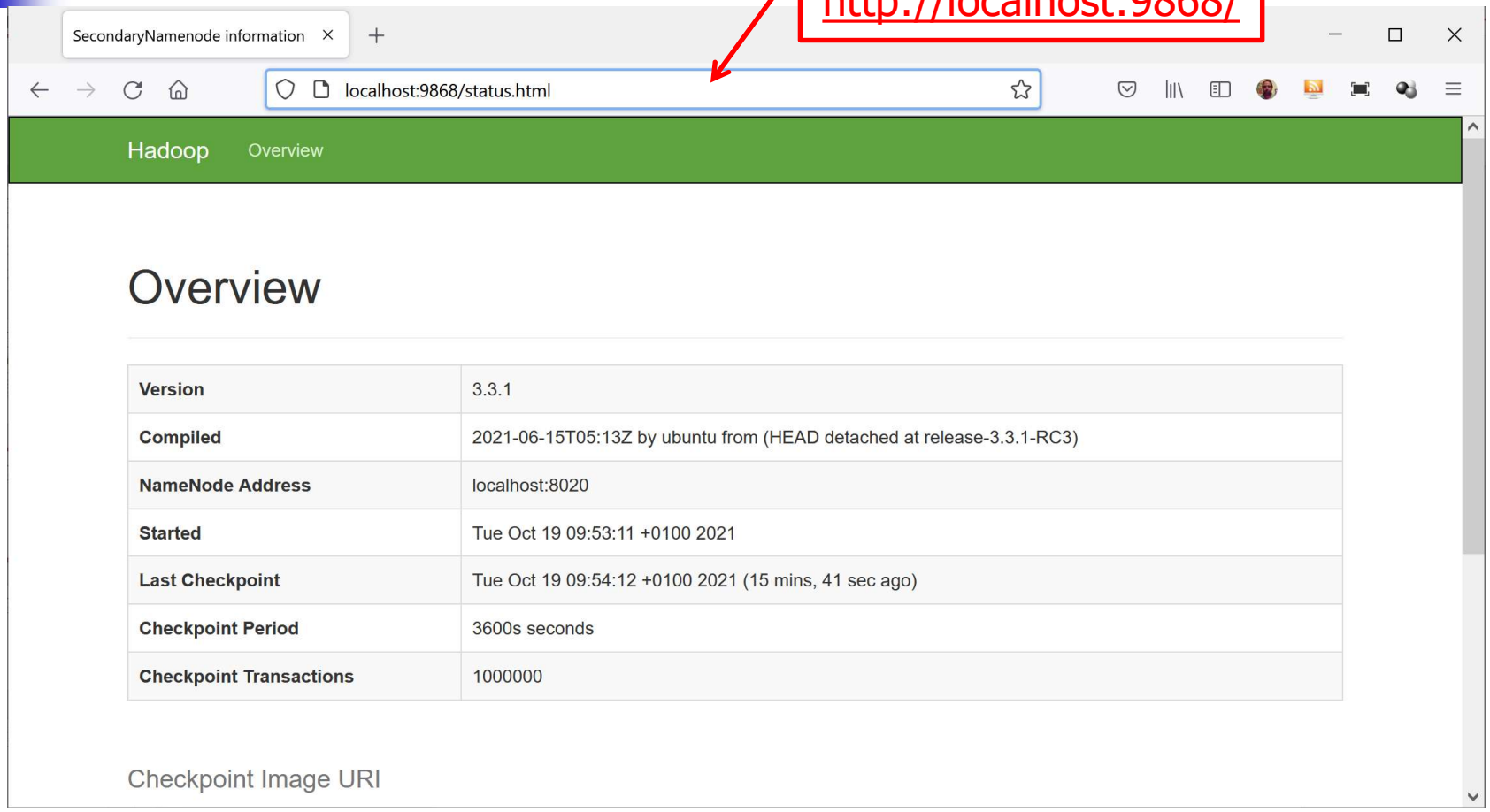
http://localhost:9870/



Configuration

Install Hadoop – Verify installation

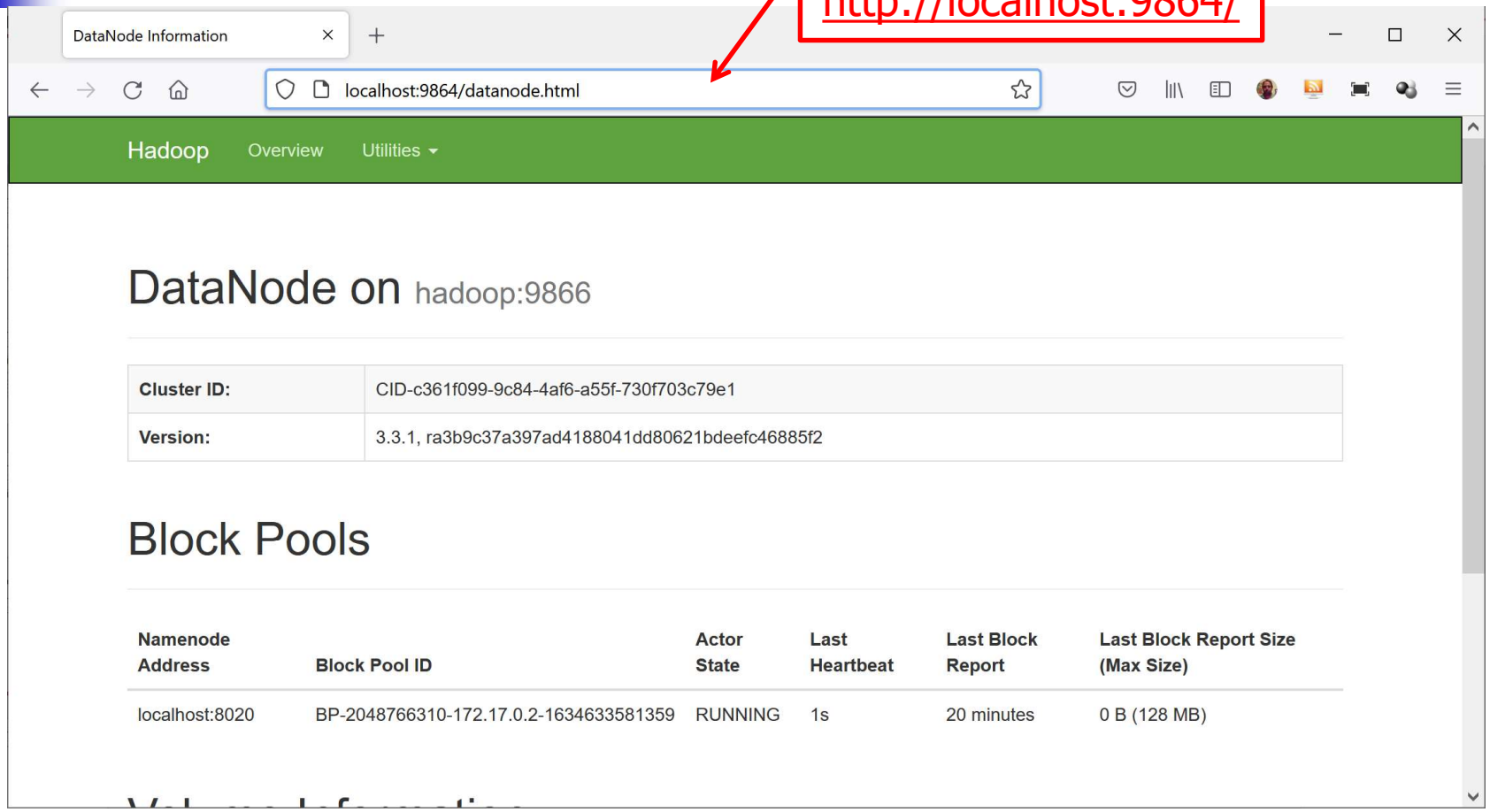
http://localhost:9868/



Configuration

Install Hadoop – Verify installation

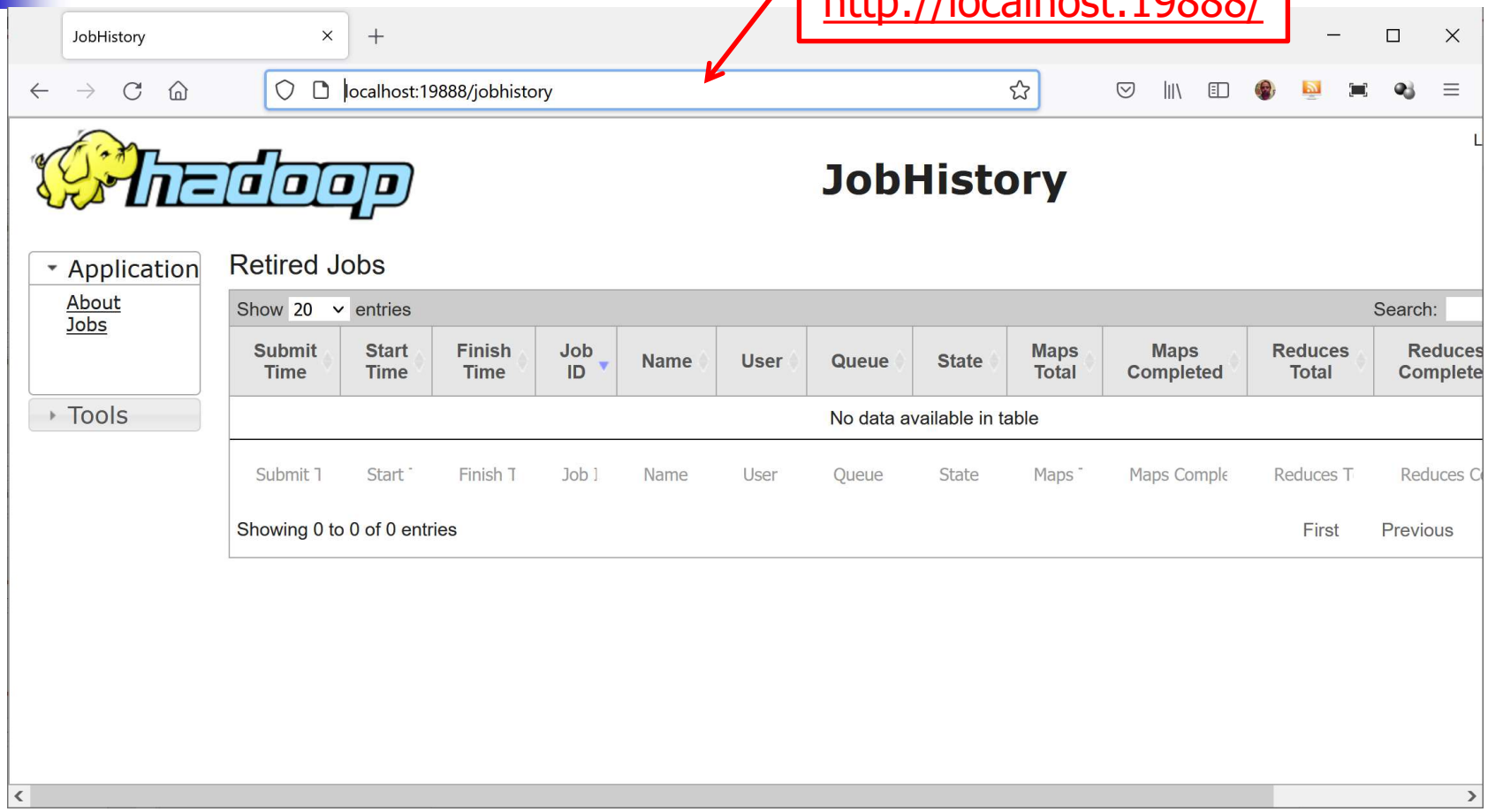
http://localhost:9864/



Configuration

Install Hadoop – Verify installation

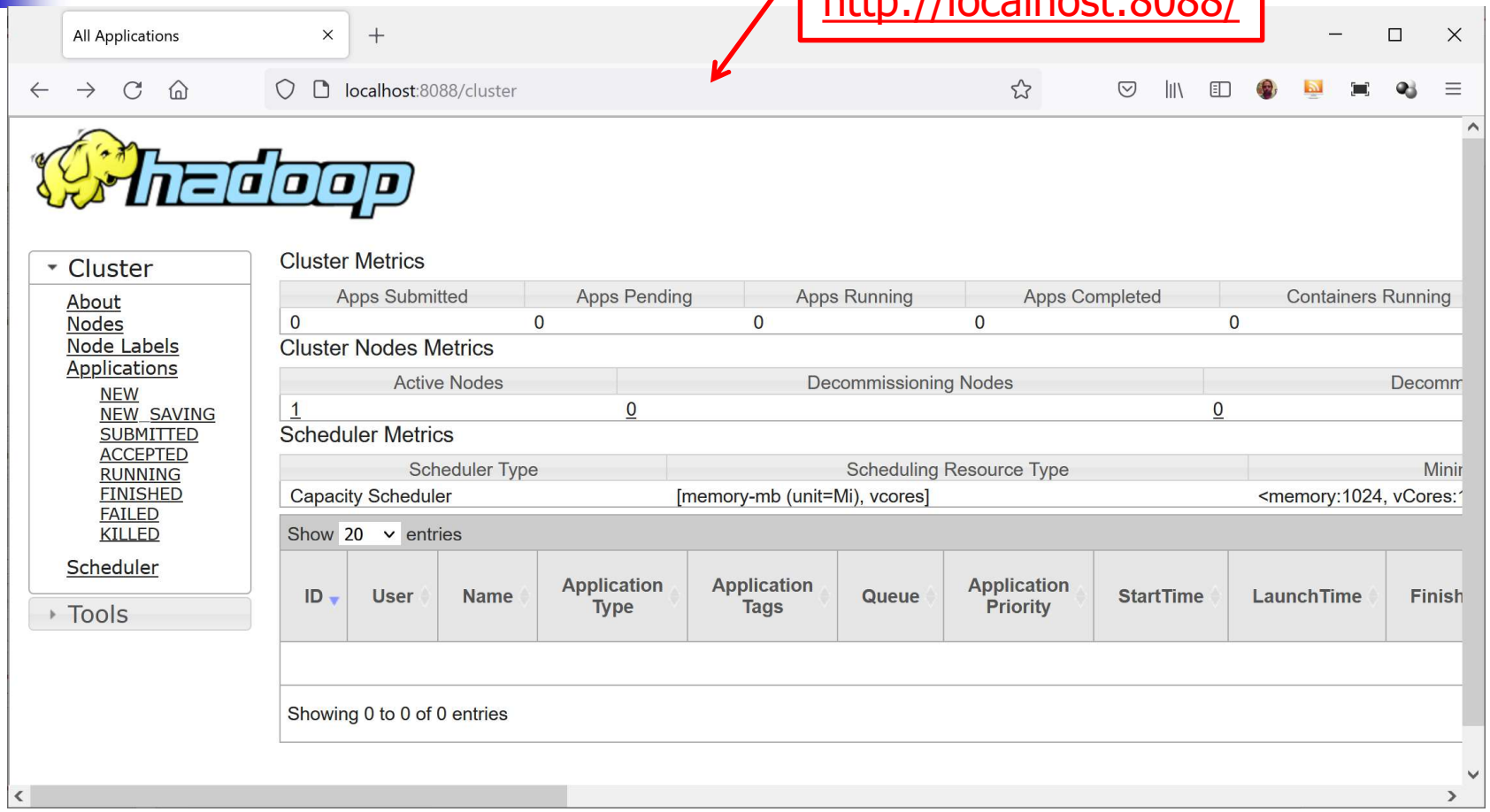
http://localhost:19888/



Configuration

Install Hadoop – Verify installation

http://localhost:8088/



Testing

Install examples

- Start a SSH session
- Upload the examples and maintain the directory structure suggested in Moodle

usermr@hadoop: ~

```
usermr@hadoop:~$ dir
total 53M
drwxr-xr-x 1 usermr usermr 4.0K Oct 19 09:30 .
drwxr-xr-x 1 root   root   4.0K Oct 19 08:52 ..
-rw-r--r-- 1 usermr usermr   33 Oct 16 12:02 .bash_aliases
-rw------- 1 usermr usermr  136 Oct 19 09:16 .bash_history
-rw-r--r-- 1 usermr usermr  220 Feb 25  2020 .bash_logout
-rw-r--r-- 1 usermr usermr 3.7K Feb 25  2020 .bashrc
drwx------ 2 usermr usermr 4.0K Oct 19 08:31 .cache
-rw-r--r-- 1 usermr usermr  844 Oct 17 09:55 .profile
drwxr-xr-x 1 usermr usermr 4.0K Oct 19 08:52 .ssh
drwxrwxr-x 2 usermr usermr 4.0K Mar 16  2021 bin
-rw-rw-r-- 1 usermr usermr  49M Oct 19 09:28 examples.zip
-rw-rw-r-- 1 usermr usermr 221K Oct 19 09:28 gutenberg.zip
drwxrwxr-x 2 usermr usermr 4.0K Oct 14 18:40 install-hadoop
-rwxr-xr-x 1 usermr usermr  179 Oct 16 11:52 setupSSH.sh
-rw-rw-r-- 1 usermr usermr 1.5M Oct 19 09:28 temperatures.zip
-rw-rw-r-- 1 usermr usermr 1.8M Oct 19 09:28 wikipedia.zip
usermr@hadoop:~$
```

Testing

Install examples

usermr@hadoop: ~/examples

```
usermr@hadoop:~/examples$ tree -d -L 2
.
|-- Demos
|-- Projects
|   |-- 01-Temperatures
|   |-- 02-WordCount
|   |-- 03-FileSystem
|   |-- 04-Streams
|   |-- 05-Configuration
|   |-- 06-MapReduce
|   `-- 07-OpenCV
|-- conf
|-- input
|   |-- gutenberg
|   |-- temperatures
|   `-- wikipedia
`-- output
    |-- imagens
    `-- videos

17 directories
usermr@hadoop:~/examples$
```

Examples

Word count examples

Directory with input data files

Directory for output data files

Testing
Install examples

- On a SSH session execute the commands:
  - cd
  - sudo chown -R usermr:hadoop examples/
  - sudo chmod -R o-w examples/
  - cd /home
  - sudo chown usermr:hadoop /home/usermr

Testing
Build examples

- `cd ~/examples/Projects/`
- `./build.sh`

```
usermr@hadoop: ~/examples/Projects
[INFO] Ex20-FileDecompressor-02 ........................... SUCCESS [  0.882 s]
[INFO] Ex21-PooledStreamCompressor ........................ SUCCESS [  0.936 s]
[INFO] 05-Configuration ................................... SUCCESS [  0.007 s]
[INFO] Ex22-ReadConfiguration-01 .......................... SUCCESS [  1.143 s]
[INFO] Ex23-ReadConfiguration-02 .......................... SUCCESS [  0.950 s]
[INFO] Ex24-ReadConfiguration-03 .......................... SUCCESS [  0.856 s]
[INFO] Ex25-ConfigurationPrinter .......................... SUCCESS [  0.844 s]
[INFO] 06-MapReduce ....................................... SUCCESS [  0.008 s]
[INFO] Ex26-MapReduce-01 .................................. SUCCESS [  0.805 s]
[INFO] Ex27-MapReduce-02 .................................. SUCCESS [  0.915 s]
[INFO] 07-OpenCV .......................................... SUCCESS [  0.010 s]
[INFO] Utils-OpenCV ....................................... SUCCESS [  0.583 s]
[INFO] Demo01-OpenCV-ExtractFramesFromVideo ............... SUCCESS [ 14.916 s]
[INFO] Demo02-OpenCV-IdentifyObjectsInPictures ............ SUCCESS [  0.600 s]
[INFO] ------------------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------------------
[INFO] Total time:  01:24 min
[INFO] Finished at: 2021-10-19T09:46:34Z
[INFO] ------------------------------------------------------------------------
usermr@hadoop:~/examples/Projects$
```

Testing

Run Word Count example

- `cd ~/examples/Projects/02-WordCount/Ex10-WordCount-01/`

usermr@hadoop: ~/examples/Projects/02-WordCount/Ex10-WordCount-01

```
usermr@hadoop:~/examples/Projects/02-WordCount/Ex10-WordCount-01$ ./run.sh
Invalid arguments!
Usage:
./run.sh <File System type>

Where <File System type> can be:

local - local file system (file://)
HDFS - HDFS file system (hdfs://)
usermr@hadoop:~/examples/Projects/02-WordCount/Ex10-WordCount-01$
```

Testing

Run Word Count example – Local file system

usermr@hadoop: ~/examples/Projects/02-WordCount/Ex10-WordCount-01

```
2021-10-19 10:13:16,527 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1634
633602826_0001
2021-10-19 10:13:16,528 INFO mapreduce.JobSubmitter: Executing with tokens: []
2021-10-19 10:13:16,664 INFO conf.Configuration: resource-types.xml not found
2021-10-19 10:13:16,665 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'
.
2021-10-19 10:13:16,834 INFO impl.YarnClientImpl: Submitted application application_1634
633602826_0001
2021-10-19 10:13:16,871 INFO mapreduce.Job: The url to track the job: http://hadoop:8088
/proxy/application_1634633602826_0001/
2021-10-19 10:13:16,871 INFO mapreduce.Job: Running job: job_1634633602826_0001
2021-10-19 10:13:22,958 INFO mapreduce.Job: Job job_1634633602826_0001 running in uber m
ode : false
2021-10-19 10:13:22,960 INFO mapreduce.Job:  map 0% reduce 0%
2021-10-19 10:13:29,064 INFO mapreduce.Job:  map 11% reduce 0%
2021-10-19 10:13:30,073 INFO mapreduce.Job:  map 22% reduce 0%
2021-10-19 10:13:31,079 INFO mapreduce.Job:  map 33% reduce 0%
```

Testing

Run Word Count example – Local file system – Results

usermr@hadoop: ~/examples/Projects/02-WordCount/Ex10-WordCount-01

```
Result sorted by key - MapReduce defaults - (first 5 lines)
hadoop fs -text file:///home/usermr/examples/output/gutenberg/mixed/part-r-00001 2>/dev/
null | head -n 5
"Defects".      8
"Defects,"      2
"House" 2
"Information    2
"Plain  4

Result sorted (by value) using the linux sort command
hadoop fs -text file:///home/usermr/examples/output/gutenberg/mixed/part-r-00001 2>/dev/
null | sort -k 2,2 -n -r | head -n 5
shall   470
this    402
is      334
any     330
as      258
usermr@hadoop:~/examples/Projects/02-WordCount/Ex10-WordCount-01$
```

Testing

Run Word Count example – HDFS file system – Results

usermr@hadoop: ~/examples/Projects/02-WordCount/Ex10-WordCount-01

```
Result sorted by key - MapReduce defaults - (first 5 lines)
hadoop fs -text hdfs:///user/usermr/output/gutenberg/mixed/part-r-00001 2>/dev/null | he
ad -n 5
"Defects".      8
"Defects,"      2
"House" 2
"Information    2
"Plain  4

Result sorted (by value) using the linux sort command
hadoop fs -text hdfs:///user/usermr/output/gutenberg/mixed/part-r-00001 2>/dev/null | so
rt -k 2,2 -n -r | head -n 5
shall   470
this    402
is      334
any     330
as      258
usermr@hadoop:~/examples/Projects/02-WordCount/Ex10-WordCount-01$
```

Testing

Run Word Count example – HDFS file system – Results

Browsing HDFS

localhost:9870/explorer.html#/user/usermr/output/gutenberg/mixed

Hadoop | Overview | Datanodes | Datanode Volume Failures | Snapshot | Startup Progress | Utilities

Browse Directory

/user/usermr/output/gutenberg/mixed Go!

Show 25 entries Search:

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
-rw-r--r--	usermr	hadoop	0 B	Oct 19 11:16	1	128 MB	_SUCCESS
-rw-r--r--	usermr	hadoop	27.52 KB	Oct 19 11:16	1	128 MB	part-r-00000
-rw-r--r--	usermr	hadoop	26.2 KB	Oct 19 11:16	1	128 MB	part-r-00001

Showing 1 to 3 of 3 entries

Previous 1 Next

Hadoop, 2021.

Testing

Run Word Count example – Jobs history

JobHistory

localhost:19888/jobhistory

Logged in as: dr.who

JobHistory

- Application
  - About
  - Jobs
- Tools

Retired Jobs

Show 20 entries

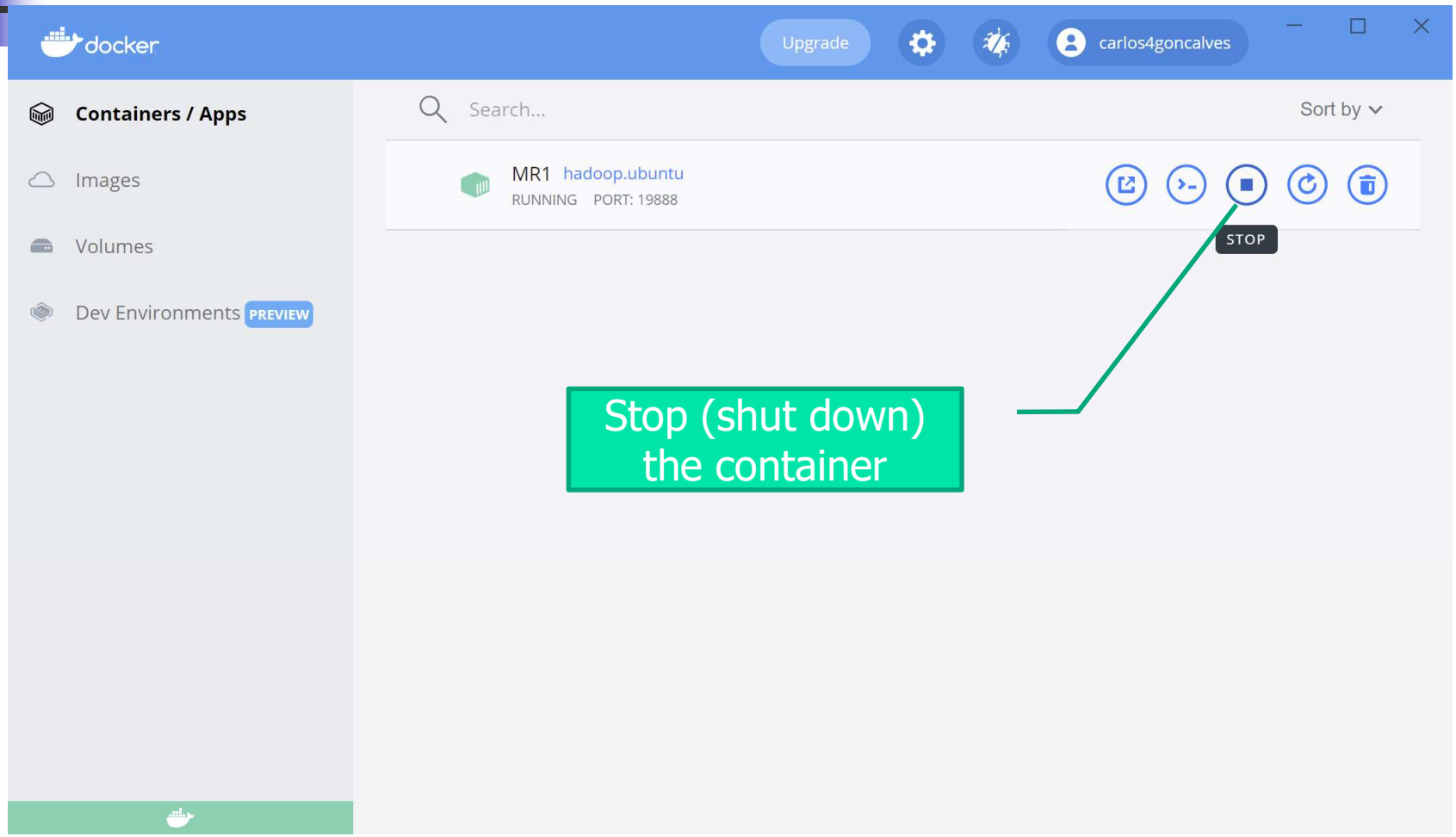
Search:

Submit Time	Start Time	Finish Time	Job ID	Name	User	Queue	State	Maps Total	Maps Completed	Reduces Total	Reduces Completed	Elapsed Time
2021.10.19 10:16:40 GMT	2021.10.19 10:16:44 GMT	2021.10.19 10:16:58 GMT	job_1634633602826_0002	Word Count Ver 1	usermr	default	SUCCEEDED	9	9	2	2	00hrs, 00mins, 13sec
2021.10.19 10:13:16 GMT	2021.10.19 10:13:21 GMT	2021.10.19 10:13:37 GMT	job_1634633602826_0001	Word Count Ver 1	usermr	default	SUCCEEDED	9	9	2	2	00hrs, 00mins, 15sec

Showing 1 to 2 of 2 entries

First Previous 1 Next Last

Shut down the container



Stop (shut down) the container

Bring up the container

- On the next login Hadoop components aren't available!
- It is necessary to explicitly bring up the Hadoop components
- The script "`07-hadoopPseudoDistributed-Start.sh`" brings up all the Hadoop components

Bring up the container