Introduction into Big Data analytics

Lecture 3a – Hadoop installation on Ubuntu

Janusz Szwabiński

Outlook:

1. VirtualBox
2. Downloading Hadoop
3. Stand-alone installation
4. Pseudo-distributed mode

VirtualBox ¶

- https://www.virtualbox.org/ (https://www.virtualbox.org/)
- follow the installation steps in the User Manual (https://www.virtualbox.org/manual/UserManual.html (https://www.virtualbox.org/manual/UserManual.html))

New virtual machine

- download Ubuntu from https://www.ubuntu.com/download/desktop (https://www.ubuntu.com/download/desktop) and install it within the virtual machine
- follow the installation tutorial at https://tutorials.ubuntu.com/tutorial/tutorial-install-ubuntu-desktop (https://tutorials.ubuntu.com/tutorial/tutorial-install-ubuntu-desktop) in case you are not familiar with GNU/Linux systems
- as an alternative, you may use one of the existing Virtual Ubuntu Images from https://www.osboxes.org/ubuntu/ (https://www.osboxes.org/ubuntu/)
- use fixed size disks, because
  - they help to avoid hadoop's unhealthy node issues related to storage size
  - they speed up your virtual machines

Resizing the virtual drive

- https://technology.amis.nl/2017/01/30/ubuntu-vm-virtualbox-increase-size-disk-make-smaller-exports-distribution/ (https://technology.amis.nl/2017/01/30/ubuntu-vm-virtualbox-increase-size-disk-make-smaller-exports-distribution/)

Accessing virtual machine from host OS

Via ssh

1. Install ssh server on a guest box.
2. Go to the network settings of the virtual machine and click the *Port Forwarding button*.
3. Add a new rule:

```
Host port 3022, guest port 22, name ssh, protocol TCP
```

4. To ssh into the guest VM, write

```
ssh -p 3022 user@127.0.0.1
```

5. To copy files between host and guest, use `sftp` instead:

```
sftp -P 3022 user@127.0.0.1
```

Important note
Other solutions are possible. Check https://www.virtualbox.org/manual/ch06.html (https://www.virtualbox.org/manual/ch06.html) for more details.

Important note #2
If your host OS is a flavor of MS Windows, you may be interested in installing:

- putty, https://www.putty.org/ (https://www.putty.org/)
- WInSCP, https://winscp.net/eng/docs/lang:pl (https://winscp.net/eng/docs/lang:pl)

Via shared folders

1. Install Guest Additions on your virtual machine.
2. Creating a shared folder:
   A. Create a folder on the Host computer that you would like to share, for example `~/share`.
   B. Boot the Guest operating system in VirtualBox.
   C. Select `Devices -> Shared Folders...`.
   D. Choose the `Add` button. Select `~/share`.
   E. Optionally select the `Make permanent` option.
3. Preparing the folder:
   - Linux guest

     ```
     sudo mount -t vboxsf -o uid=$UID,gid=$(id -g) share ~/host
     ```

   - Windows guest

     ```
     net use x: \\vboxsvr\share
     ```

Important note
In case you get a `Permission denied` error while trying to access the folder on a Linux guest, add your user to the `vboxsf` group:

```
sudo usermod -a -G vboxsf szwabin
```

Software installation

Java

```
sudo apt-get install openjdk-8-jdk
```

For setting up `JAVA_HOME` and `PATH` variables, add the following lines to the .bashrc file in your `$HOME` directory:

```
export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64/
export PATH=$PATH:$JAVA_HOME/bin
```

(on Ubuntu 16.04)

Apply changes into the current running system with

```
source ~/.bashrc
```

SSH server

```
sudo apt-get install openssh-server
```

You may want to generate RSA keys for passphraseless usage:

```
ssh-keygen -t rsa
cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys
chmod 0600 ~/.ssh/authorized_keys
```

ViM text editor (optionally)

```
sudo apt-get install vim
```

Important note
In case you do not know an exact package name, you can search the available packages in the Ubuntu repository with

```
apt-cache search keyword
```

Hadoop

- go to http://hadoop.apache.org/releases.html (http://hadoop.apache.org/releases.html) and download the latest stable release
- extract the archive in a directory of your choice (e.g. `/usr/local`) with

```
tar xzf hadoop-your-version.tar.gz
```

Hadoop operation modes

- **Local/Standalone** mode
  - default configuration of fresh installed Hadoop
  - Hadoop can be run as a single java process
- **Pseudo Distributed** mode
  - a distributed simulation on single machine
  - each Hadoop daemon such as hdfs, yarn, MapReduce etc. will run as a separate java process
  - useful for development and experimenting with Hadoop
- **Fully Distributed** mode
  - minimum two or more machines as a cluster

Stand-alone Hadoop installation

- no daemons running
- everything runs in a single JVM
- suitable for running MapReduce programs during development (easy to test and debug them)

Installation

Unpack the Hadoop distribution to a directory of your choice, for instance `/usr/local/hadoop`

Configuration

- `hadoop-env.sh`

```
export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64
```

- `.bashrc`

```
# setting up Java environment
export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64
export PATH=$PATH:$JAVA_HOME/bin

# setting up Hadoop
export HADOOP_HOME=/usr/local/hadoop
export PATH=$PATH:$HADOOP_HOME/bin
```

In order to update the variables set up in the `.bashrc` file, issue the command

```
source .bashrc
```

Test

- Hadoop installation delivers an example MapReduce jar file

In [1]:

```
!hadoop jar $HADOOP_HOME/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.0.0.jar
```

```
An example program must be given as the first argument.
Valid program names are:
  aggregatewordcount: An Aggregate based map/reduce program that co
unts the words in the input files.
  aggregatewordhist: An Aggregate based map/reduce program that com
putes the histogram of the words in the input files.
  bbp: A map/reduce program that uses Bailey-Borwein-Plouffe to com
pute exact digits of Pi.
  dbcount: An example job that count the pageview counts from a dat
abase.
  distbbp: A map/reduce program that uses a BBP-type formula to com
pute exact bits of Pi.
  grep: A map/reduce program that counts the matches of a regex in
the input.
  join: A job that effects a join over sorted, equally partitioned
datasets
  multifilewc: A job that counts words from several files.
  pentomino: A map/reduce tile laying program to find solutions to
pentomino problems.
  pi: A map/reduce program that estimates Pi using a quasi-Monte Ca
rlo method.
  randomtextwriter: A map/reduce program that writes 10GB of random
textual data per node.
  randomwriter: A map/reduce program that writes 10GB of random dat
a per node.
  secondarysort: An example defining a secondary sort to the reduc
e.
  sort: A map/reduce program that sorts the data written by the ran
dom writer.
  sudoku: A sudoku solver.
  teragen: Generate data for the terasort
  terasort: Run the terasort
  teravalidate: Checking results of terasort
  wordcount: A map/reduce program that counts the words in the inpu
t files.
  wordmean: A map/reduce program that counts the average length of
the words in the input files.
  wordmedian: A map/reduce program that counts the median length of
the words in the input files.
  wordstandarddeviation: A map/reduce program that counts the stand
ard deviation of the length of the words in the input files.
```

- it provides basic functionality of MapReduce
- it can be used for computations (e.g. Pi value), word counts in a given list of files, etc.

Let us have an `input` directory where we will push a few text files. Our goal is to count the total number of words in those files:

- we do not need to write a MapReduce application
- word count functionality is included in the example jar

```
hadoop jar $HADOOP_HOME/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.0.0.jar wordcount MyMR/ output
```

Pseudo-distributed mode

First attempt

- default Ubuntu installation within VirtualBox
- 10 GB virtual disc with a dynamic size

Configuration

- `.bashrc` in your home directory

```
# setting up Java environment
export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64
export PATH=$PATH:$JAVA_HOME/bin

# setting up Hadoop
export HADOOP_HOME=/home/szwabin/Tools/hadoop-3.0.0
export PATH=$PATH:$HADOOP_HOME/bin:$HADOOP_HOME/sbin
export HADOOP_MAPRED_HOME=$HADOOP_HOME
export HADOOP_COMMON_HOME=$HADOOP_HOME
export HADOOP_HDFS_HOME=$HADOOP_HOME
export YARN_HOME=$HADOOP_HOME
export HADOOP_COMMON_LIB_NATIVE_DIR=$HADOOP_HOME/lib/native
export HADOOP_INSTALL=$HADOOP_HOME
```

- `core-site.xml` in `$HADOOP_HOME/etc/hadoop` directory

```
<configuration>
  <property>
      <name>fs.default.name</name>
      <value>hdfs://localhost:9000</value>
  </property>
</configuration>
```

- `hdfs-site.xml` in `$HADOOP_HOME/etc/hadoop` directory

```
<configuration>

    <property>
        <name>dfs.replication</name>
        <value>1</value>
    </property>

    <property>
        <name>dfs.name.dir</name>
        <value>file:///home/szwabin/hadoopinfra/hdfs/namenode</value>
    </property>

    <property>
        <name>dfs.data.dir</name>
        <value>file:///home/szwabin/hadoopinfra/hdfs/datanode</value>
    </property>

</configuration>
```

- `mapred-site.xml` in `$HADOOP_HOME/etc/hadoop` directory

```
<configuration>
    <property>
        <name>mapreduce.framework.name</name>
        <value>yarn</value>
    </property>
</configuration>
```

- `yarn-site.xml` in `$HADOOP_HOME/etc/hadoop` directory

```
<configuration>
    <property>
        <name>yarn.nodemanager.aux-services</name>
        <value>mapreduce_shuffle</value>
    </property>
</configuration>
```

Formatting the HDFS

```
hdfs namenode -format
```

You should see something like

```
2018-03-08 11:46:33,556 INFO namenode.NameNode: STARTUP_MSG:
/************************************************************
STARTUP_MSG: Starting NameNode
STARTUP_MSG:   host = enterprise/127.0.1.1
STARTUP_MSG:   args = [-format]
STARTUP_MSG:   version = 3.0.0
<snip>
2018-03-08 11:46:34,160 INFO namenode.NameNode: SHUTDOWN_MSG:
/************************************************************
SHUTDOWN_MSG: Shutting down NameNode at enterprise/127.0.1.1
************************************************************/
```

Starting DFS

```
start-dfs.sh
```

The result should be similar to

```
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [enterprise]
2018-03-08 11:50:47,280 WARN util.NativeCodeLoader: Unable to load native
-hadoop library for your platform... using builtin-java classes where app
licable
```

Starting Yarn

```
start-yarn.sh
```

The result should be as follows:

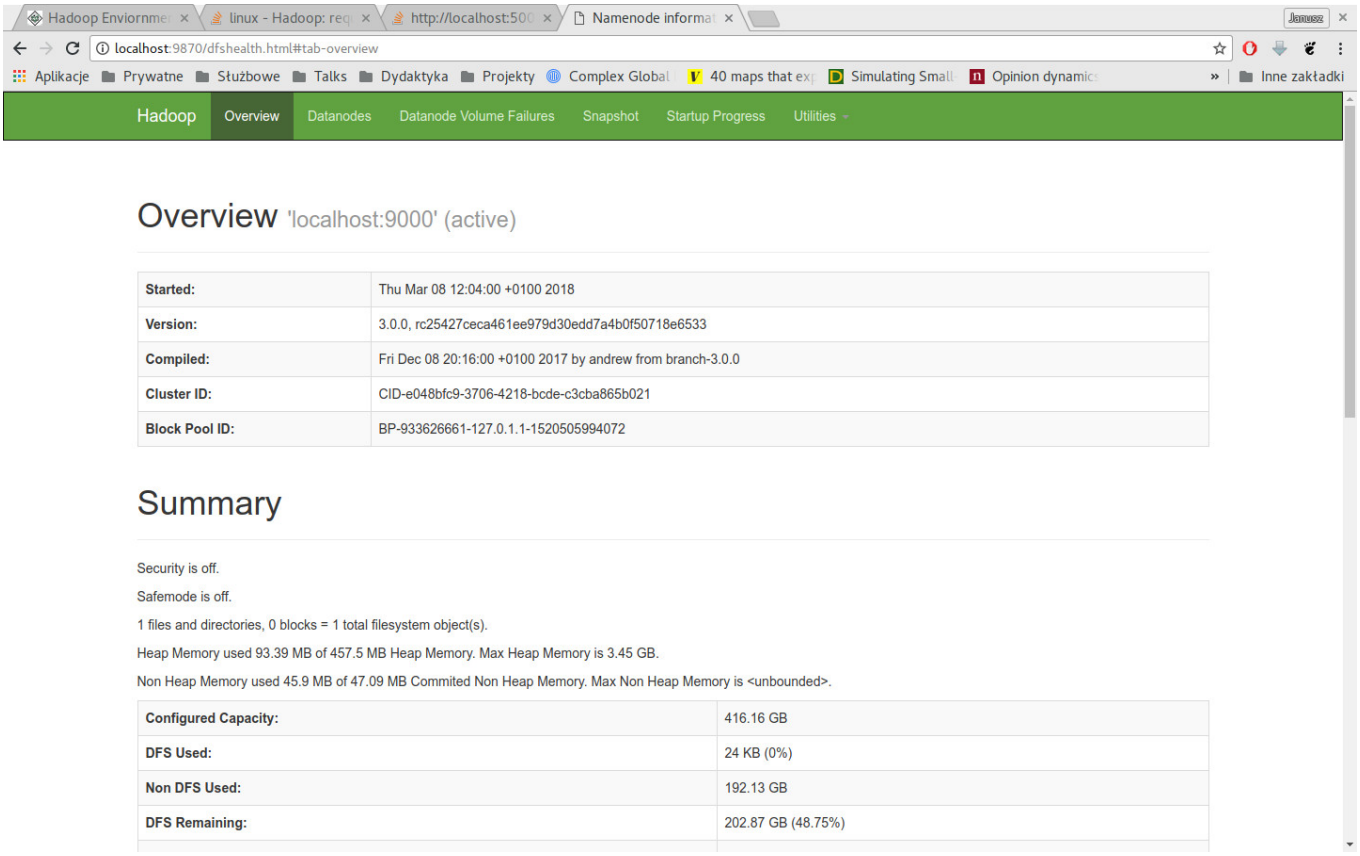
```
Starting resourcemanager
Starting nodemanagers
```

Accessing Hadoop

We can access Hadoop via browser at

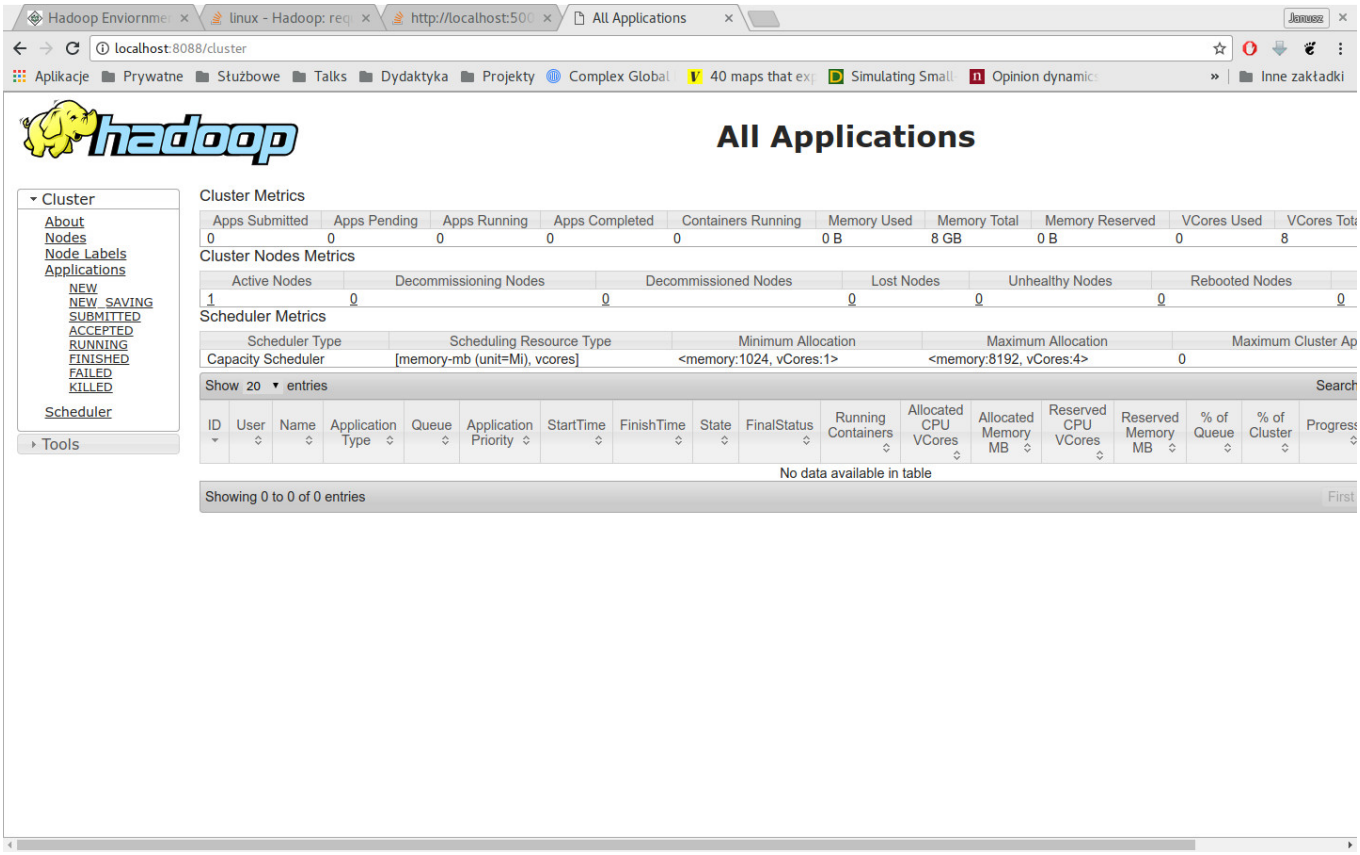
```
http://localhost:9870/
```

(in older versions of Hadoop the port is 50070)



The default port number to access all applications of the cluster is 8088:

```
http://localhost:8088/
```



Creating working directory

```
hadoop fs -mkdir /input
```

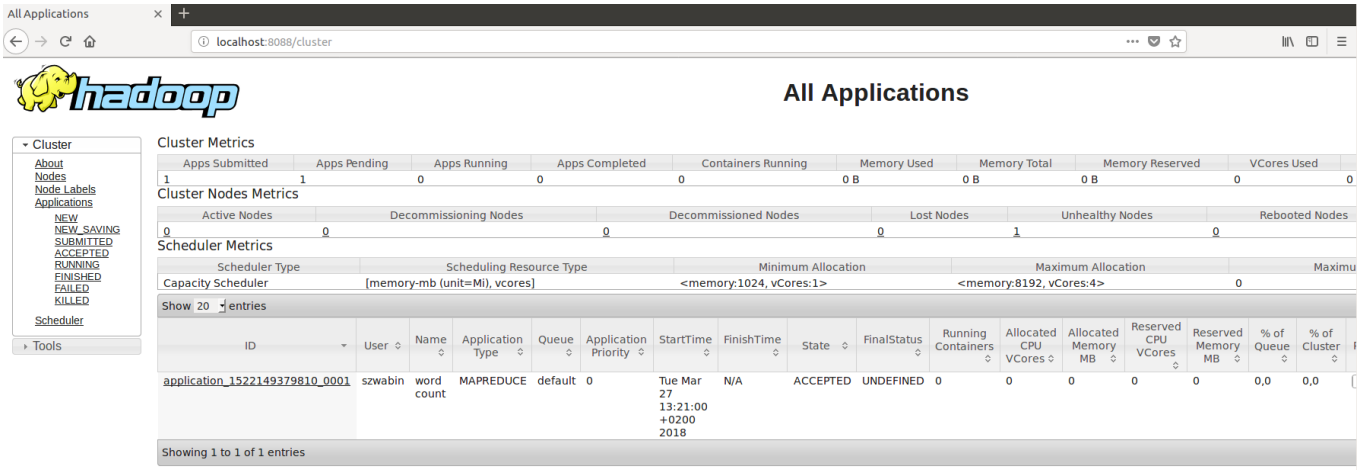
Preparing example data

```
hadoop fs -put $HADOOP_HOME/*.txt /input
```

Starting a MapReduce example

```
hadoop jar $HADOOP_HOME/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.0.0.jar wordcount /input /output
```

- usually, the job will be submitted but not finished
- a closer look at the status of the cluster reveals, that there are
  - 0 active nodes
  - 1 unhealthy node



- the node is unhealthy due to the fact that there is no more usable disk space

Second attempt

- 40 GB virtual disc (fixed size)
- same Hadoop configuration
- in this case, you usually get the following (or similar) error message while running the mapreduce job:

```
Could not find or load main class org.apache.hadoop.mapred.YarnChild
```

Third attempt

To solve the above issue, simply update the classpath in your `.bashrc` file:

```
# setting up Java environment
export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64
export PATH=$PATH:$JAVA_HOME/bin

# setting up Hadoop
export HADOOP_HOME=/home/szwabin/Tools/hadoop-3.0.0
export PATH=$PATH:$HADOOP_HOME/bin:$HADOOP_HOME/sbin
export HADOOP_MAPRED_HOME=$HADOOP_HOME
export HADOOP_COMMON_HOME=$HADOOP_HOME
export HADOOP_HDFS_HOME=$HADOOP_HOME
export YARN_HOME=$HADOOP_HOME
export HADOOP_COMMON_LIB_NATIVE_DIR=$HADOOP_HOME/lib/native
export HADOOP_INSTALL=$HADOOP_HOME
export HADOOP_CLASSPATH=$(hadoop classpath):$HADOOP_CLASSPATH
```

Fourth attempt

After saving the file and updating the environment, the above error disappeared, but I got the following message instead:

```
Container [pid=...] is running beyond virtual memory limits.
```

To solve that, we should properly configure the maximum memory allocations for MapReduce (file `mapred-site.xml`):

```
    <configuration>
        <property>
            <name>mapreduce.framework.name</name>
            <value>yarn</value>
        </property>

        <property>
            <name>mapreduce.admin.user.env</name>
            <value>HADOOP_MAPRED_HOME=$HADOOP_HOME</value>
        </property>

        <property>
            <name>yarn.app.mapreduce.am.env</name>
            <value>HADOOP_MAPRED_HOME=$HADOOP_HOME</value>
        </property>

        <property>
            <name>mapreduce.map.memory.mb</name>
            <value>2048</value>
        </property>

        <property>
            <name>mapreduce.reduce.memory.mb</name>
            <value>4096</value>
        </property>

        <property>
            <name>mapreduce.map.java.opts</name>
            <value>-Xmx1024m</value>
        </property>

        <property>
            <name>mapreduce.reduce.java.opts</name>
            <value>-Xmx3072m</value>
        </property>

    </configuration>
```

In [ ]: