

Spinning Up a Free Hadoop Cluster: Step by Step

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The DevOps series covers how to get started with the leading open source distributed technologies. In the first post of this series we step through how to spin up a small cluster on Amazon Web Services and deploy a basic Hadoop framework for distributed storage and processing.

One of the significant hurdles in learning to build distributed systems is understanding how these various technologies are installed and their inter-dependencies. In our experience, the best way to get started with these technologies is to roll up your sleeves and build projects you are passionate about.

The following tutorial shows how you can spin up your own personal cluster on AWS and deploy Hadoop. By no means are these production level setups, but it helps you quickly start interacting with Hadoop's distributed file system and even run MapReduce jobs.

- Spin Up AWS Micro-Instances
- SSH Configuration
- Install Hadoop
- Start Hadoop Cluster
- Working with HDFS

Before we begin, it's important to roughly understand the three components of Apache Hadoop project:

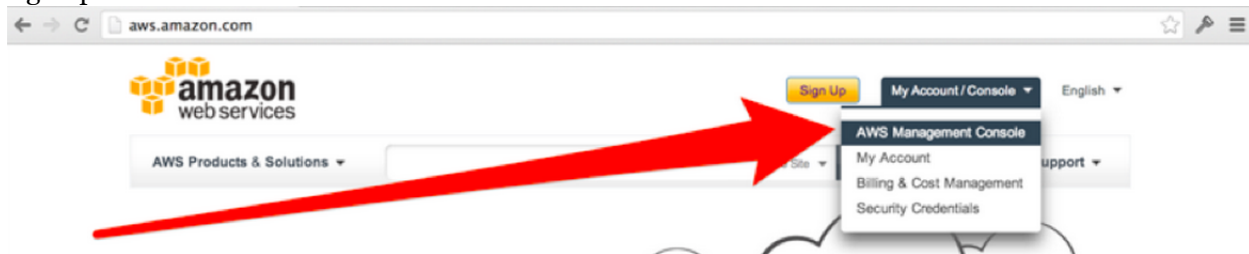
1. Hadoop Distributed File System (HDFS) is a distributed file system based off Google File System (GFS) that splits files into "blocks" and stores them redundantly on several relatively cheap machines, known as DataNodes. Access to these DataNodes is coordinated by a relatively high-quality machine, known as a NameNode.

2. Hadoop MapReduce (based off Google MapReduce) is a paradigm for distributed computing that splits computations across several machines. In the Map task, each machine in the cluster calculates a user-defined function on a subset of the input data. The outputted data of the Map task is shuffled around the cluster of machines to be grouped or aggregated in the Reduce task.
3. YARN (unofficially Yet Another Resource Negotiator) is a new feature in Hadoop 2.0 (released in 2013) that manages resources and job scheduling, much like an operating system. This is an important improvement, especially in productions with multiple applications and users, but we won't focus on this for now.

Spin up AWS EC2 Instances

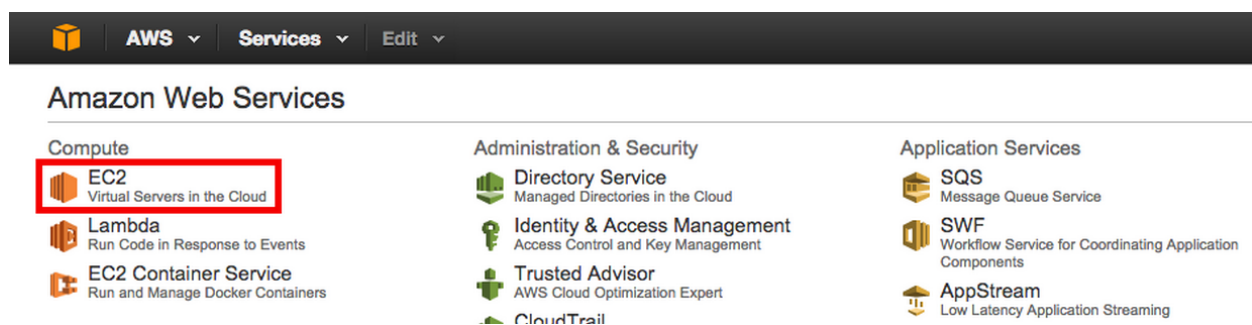
AWS provides on-demand computing resources and services in the cloud, with pay-as-you-go pricing. For example, you can run a server on AWS that you can log on to, configure, secure, and run just as you would a server that's sitting in front of you. As well as selling premium instances, AWS also offers free micro-instances for one year which you can use for this tutorial.

Log into your AWS account under aws.amazon.com. If you currently don't have one, go ahead and sign up for one.



Launching Multiple AWS Micro-Instances

You can do a lot of different things with AWS. For now, let's just start a virtual machine. Click on EC2 ("Elastic Cloud Compute").



Click on "Launch Instance". It's worth noting that AWS has different regions, and that you can launch an instance in any of them. (So if you've always wanted a server in Brazil or Japan, this is your chance!) Your choice will affect both latency and price — by default, it's best to go with the region that's closest to you.

EC2 Dashboard

Events
Tags
Reports
Limits

INSTANCES
Instances
Spot Requests
Reserved Instances

IMAGES
AMIs
Bundle Tasks

ELASTIC BLOCK STORE

Resources

You are using the following Amazon EC2 resources in the US West (N. California) region:

- 0 Running Instances
- 0 Elastic IPs
- 0 Volumes
- 0 Snapshots
- 0 Key Pairs
- 0 Load Balancers
- 0 Placement Groups
- 0 Security Groups

Automate application deployments to EC2 with [CodeDeploy](#). [Hide](#)

Create Instance

To start using Amazon EC2 you will want to launch a virtual server, known as an Amazon EC2 instance.

[Launch Instance](#)

Account Attributes

Supported Platforms
VPC
Default VPC
vpc-f00bee95

Additional Information

Getting Started Guide
Documentation
All EC2 Resources
Forums
Pricing
Contact Us

Now it's time to select the image for your VM. For this tutorial, we'll use Ubuntu Server 14.04 LTS (HVM). Be sure to select the 64-bit.

Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

Quick Start

My AMIs
AWS Marketplace
Community AMIs

☒ Free tier only [i](#)

1 to 22 of 22 AMIs

	Amazon Linux AMI 2015.03 (HVM), SSD Volume Type - ami-d114f295	Select
The Amazon Linux AMI is an EBS-backed, AWS-supported image. The default image includes AWS command line tools, Python, Ruby, Perl, and Java. The repositories include Docker, PHP, MySQL, PostgreSQL, and other packages.		
Root device type: ebs Virtualization type: hvm		
	Red Hat Enterprise Linux 7.1 (HVM), SSD Volume Type - ami-a540a5e1	Select
Red Hat Enterprise Linux version 7.1 (HVM), EBS General Purpose (SSD) Volume Type		
Root device type: ebs Virtualization type: hvm		
	SUSE Linux Enterprise Server 12 (HVM), SSD Volume Type - ami-b95b4ffc	Select
SUSE Linux Enterprise Server 12 (HVM), EBS General Purpose (SSD) Volume Type. Public Cloud, Advanced Systems Management, Web and Scripting, and Legacy modules enabled.		
Root device type: ebs Virtualization type: hvm		
	Ubuntu Server 14.04 LTS (HVM), SSD Volume Type - ami-df6a8b9b	Select
Ubuntu Server 14.04 LTS (HVM), EBS General Purpose (SSD) Volume Type. Support available from Canonical (http://www.ubuntu.com/cloud/services).		

Now choose your instance size. t2.micro instances should be sufficient to start playing with HDFS and MapReduce. Be sure to terminate the instances if you want AWS to keep more free credits for the month. For practice you can try spinning up 4 nodes, treating one as the NameNode(master) and the remaining three as DataNodes.

Filter by: All instance types Current generation Show/Hide Columns

Currently selected: t2.micro (Variable ECUs, 1 vCPUs, 2.5 GHz, Intel Xeon Family, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
<input checked="" type="checkbox"/>	General purpose	t2.micro <small>Free tier eligible</small>	1	1	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.small	1	2	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	t2.medium	2	4	EBS only	-	Low to Moderate
<input type="checkbox"/>	General purpose	m3.medium	1	3.75	1 x 4 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.large	2	7.5	1 x 32 (SSD)	-	Moderate
<input type="checkbox"/>	General purpose	m3.xlarge	4	15	2 x 40 (SSD)	Yes	High

[Cancel](#)
[Previous](#)
[Review and Launch](#)
[Next: Configure Instance Details](#)

We can then specify the number of instances to spin up. In this tutorial we will spin up 4 instances where 1 node will act as the NameNode and the remaining 3 will be DataNodes.

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot Instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances ⓘ

We will use the default storage size for each instance. In the future, if you plan on storing larger amounts of data, here is the place to change it before launching the instances.

Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. [Learn more](#) about storage options in Amazon EC2.

Type ⓘ	Device ⓘ	Snapshot ⓘ	Size (GiB) ⓘ	Volume Type ⓘ	IOPS ⓘ	Delete on Termination ⓘ
Root	/dev/sda1	snap-bd9c25fb	<input type="text" value="8"/>	General Purpose (S)	24 / 3000	<input checked="" type="checkbox"/>
Add New Volume						

Next we can give these instances a name so they are easily recognizable among other potential instances in your account. Here we gave all the instances the name 'master'. This can be modified as well after you have launched your instances.

Step 5: Tag Instance

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver. [Learn more](#) about tagging your Amazon EC2 resources.

Key (127 characters maximum)	Value (255 characters maximum)
Name	master

Create Tag (Up to 10 tags maximum)

The next step will be to configure the security groups setting for these instances. For this exercise, all the ports are open for ease of access. It should be noted that these settings should be much more strict if put in production. If a security group does not exist with the following configuration, you can create a new security group with the following settings.

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. [Learn more](#) about Amazon EC2 security groups.

Assign a security group: ☐ Create a new security group
☒ Select an existing security group

Security	Name	Description
<input type="checkbox"/>	sg-8e2780eb	default
<input type="checkbox"/>	sg-bf9d00da	default_elb_ed3b4df1-c807-3408-9314-8439205940f8
<input type="checkbox"/>	sg-e6e10f82	kuanlin-at-insight data engineer created 2015-06-09T15:16:48.25
<input type="checkbox"/>	sg-08ed0e6c	launch-wizard-1 created 2015-06-02T11:38:25.335-07:00
<input type="checkbox"/>	sg-a826cccc	launch-wizard-2 created 2015-06-15T20:13:54.815-07:00
<input checked="" type="checkbox"/>	sg-9206aaf7	open

Inbound rules for sg-9206aaf7 (Selected security groups: sg-9206aaf7)

Type	Protocol	Port Range	Source
All traffic	All	All	0.0.0.0/0

Cancel Previous Review and Launch

We will then review our instances and launch.

Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.



Improve your instances' security. Your security group, `ssh_all`, is open to the world.

Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only.

You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. [Edit security groups](#)

AMI Details

[Edit AMI](#)

Ubuntu Server 14.04 LTS (HVM), SSD Volume Type - ami-5189a661

Ubuntu Server 14.04 LTS (HVM), EBS General Purpose (SSD) Volume Type. Support available from Canonical (<http://www.ubuntu.com/cloud/services>).

Root Device Type: ebs Virtualization type: hvm

Instance Type

[Edit instance type](#)

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	Variable	1	1	EBS only	-	Low to Moderate

Security Groups

[Edit security groups](#)[Cancel](#)[Previous](#)[Launch](#)

You will then be asked to choose a pem-key which will be used to login to these instances. If this is your first time, you can generate a new pem-key and download it to your computer. For this tutorial we will assume you have saved the pem key to the `~/.ssh` folder. **WARNING: If you lose your pem-key there is no way to recover it and thus lose access to any instances that are associated with this pem-key.**

Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.



Improve your instances' security. Your security group, `ssh_all`, is open to the world.

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AMI Details

[Edit AMI](#)

Ubuntu Server 14.04 LTS (HVM), SSD Volume Type - ami-5189a661

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Root Device Type: ebs Virtualization type: hvm

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[Edit instance type](#)

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	Variable	1	1	EBS only	-	Low to Moderate

Security Groups

[Edit security groups](#)[Cancel](#)[Previous](#)[Launch](#)

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about [removing existing key pairs from a public AMI](#).

Create a new key pair

Key pair name

my-personal-key

[Download Key Pair](#)

You have to download the **private key file** (*.pem file) before you can continue. **Store it in a secure and accessible location.** You will not be able to download the file again after it's created.

[Cancel](#)[Launch Instances](#)

Congratulations! Your AWS instance is now spinning up! Let's log into it.

Launch Status

✓ Your instance is now launching

The following instance launch has been initiated: [i-e6d5e7eb](#) [View launch log](#)

... Get notified of estimated charges

[Create billing alerts](#) to get an email notification when estimated charges on your AWS bill exceed an amount you define (for example, if you exceed the free usage tier).

Logging into an EC2 Instance

Return to the AWS console. You should now see “4 Running Instances” if you chose 4 instances in the beginning. Click on it.

Resources

You are using the following Amazon EC2 resources in the US West (Oregon) region:

4 Running Instances

8 Volumes

5 Key Pairs

0 Placement Groups

4 Elastic IPs

3 Snapshots

0 Load Balancers

6 Security Groups

You can then choose one of these instances. You can rename the instances by clicking the pencil to the right of the instance name, which will be helpful for technologies that use a single “master” that needs to be distinguished from than the rest. You should now be able to see the public IP address of your Virtual Machine (VM). This is the endpoint we’re going to use to SSH into the machine.

Launch Instance

Connect

Actions

Search

Name : master

Instance Type : t2.micro

Add filter

	Name	Instance	Availability Zone	Instance State	Status Checks	Public DNS	Public IP
<input checked="" type="checkbox"/>	master	t2.micro	us-west-2a	running	✓ 2/2 checks ...	ec2-52-26-74-172.us-...	52.26.74.172
<input type="checkbox"/>	master	t2.micro	us-west-2a	running	✓ 2/2 checks ...	ec2-52-25-230-98.us-...	52.25.230.98
<input type="checkbox"/>	master	t2.micro	us-west-2a	running	✓ 2/2 checks ...	ec2-52-26-71-87.us-w...	52.26.71.87
<input type="checkbox"/>	master	t2.micro	us-west-2a	running	✓ 2/2 checks ...	ec2-52-24-2-247.us-w...	52.24.2.247

Instance: i-473b57b0 (master)

Public DNS: ec2-52-26-74-172.us-west-2.compute.amazonaws.com

Description

Status Checks

Monitoring

Tags

Instance ID

i-473b57b0

Public DNS

ec2-52-26-74-172.us-west-2.compute.amazonaws.com

Instance state

running

Public IP

52.26.74.172

Instance type

t2.micro

Elastic IP

-

Private DNS

ip-172-31-34-113.us-west-2.compute.internal

Availability zone

us-west-2a

For the remainder of this tutorial, we will be referencing the Public DNS quite a bit when installing Hadoop. In any code snippets where there is **bolded text**, you will need to swap it out with appropriate values.

For example, `namenode_public_dns` should be replaced with something like `ec2-52-26-74-172.us-west-2.compute.amazonaws.com`

e.g:
your Namenode public DNS is `ec2-52-26-74-172.us-west-2.compute.amazonaws.com`
local\$ ssh -i ~/.ssh/my-pem-key.pem ubuntu@namenode_public_dns
should translate to
local\$ ssh -i ~/.ssh/my-pem-key.pem ubuntu@ec2-52-26-74-172.us-west-2.compute.amazonaws.com

Fellows in the past have found it useful to simply copy all the Public DNSs into a text file for easy reference later on. At this point you should decide which Public DNS will be the NameNode and the remaining Public DNSs be the DataNodes.

Example text file:

```
namenode_public_dns => ec2-52-26-74-172.us-west-2.compute.amazonaws.com
datanode1_public_dns => ec2-52-26-34-168.us-west-2.compute.amazonaws.com
datanode2_public_dns => ec2-52-26-27-192.us-west-2.compute.amazonaws.com
datanode3_public_dns => ec2-52-26-36-112.us-west-2.compute.amazonaws.com
```

You need to change the permissions of the pem key that you downloaded from AWS earlier. Do this with the command otherwise SSH'ing will complain that the key is too open (bolded code would be different for your setup):

```
local$ sudo chmod 600 ~/.ssh/pem_key_filename
```

Now let's SSH into the machine with the following SSH command template:

```
local$ ssh -i ~/.ssh/pem_key_filename ubuntu@namenode_public_dns
```

If prompted "Are you sure that you want to continue?", enter "yes". After verifying that you can SSH into a node, you can exit with the command `exit` or `Ctrl-D`.

SSH Configuration

We can make our lives easier by setting up a config file in the `~/.ssh` directory such that we do not have to specify the pem key and host address every time we SSH into a node from our local machine. Simply place the following into the `~/.ssh/config` file. Create one, if it does not exist.

`~/.ssh/config`:

```
Host namenode
  HostName namenode_public_dns
  User ubuntu
  IdentityFile ~/.ssh/pem_key_filename
Host datanode1
  HostName datanode1_public_dns
  User ubuntu
  IdentityFile ~/.ssh/pem_key_filename
Host datanode2
  HostName datanode2_public_dns
  User ubuntu
  IdentityFile ~/.ssh/pem_key_filename
Host datanode3
  HostName datanode3_public_dns
  User ubuntu
  IdentityFile ~/.ssh/pem_key_filename
```

Passwordless SSH

The NameNode in the Hadoop cluster needs to be able to communicate with the other DataNodes in the cluster. This is done by configuring passwordless SSH between the NameNode and the DataNodes.

We will first need to transfer your pem key from your local computer to the NameNode. This allows us to initially SSH into DataNodes from the NameNode. We will also copy over the config file in our `~/.ssh` folder.

```
local$ scp ~/.ssh/pem_key_filename ~/.ssh/config namenode:~/.ssh
```

Next we will SSH into the NameNode and create an authorization key. This fingerprint will then be added to the `authorized_keys` file on the NameNode and all the DataNodes. The first time you SSH into the node it will probably ask you if you are sure you want to connect. Answer yes. For example you may see something like this:

```
local$ ssh namenode
The authenticity of host 'ec2-52-26-234-93.us-west-2.compute.amazonaws.com
(172.31.35.245)' can't be established. ECDSA key fingerprint is
df:2f:34:e7:2d:51:7b:b2:38:86:b8:f0:c6:c2:8d:0b.
Are you sure you want to continue connecting (yes/no)? yes
```

On the NameNode we can create the public fingerprint, found in `~/.ssh/id_rsa.pub`, and add it first to the NameNode's `authorized_keys`

```
namenode$ ssh-keygen -f ~/.ssh/id_rsa -t rsa -P ""
namenode$ cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys
```

Now we need to copy the public fingerprint to each DataNode's `~/.ssh/authorized_keys`. This should enable the password-less SSH capabilities from the NameNode to any DataNode.

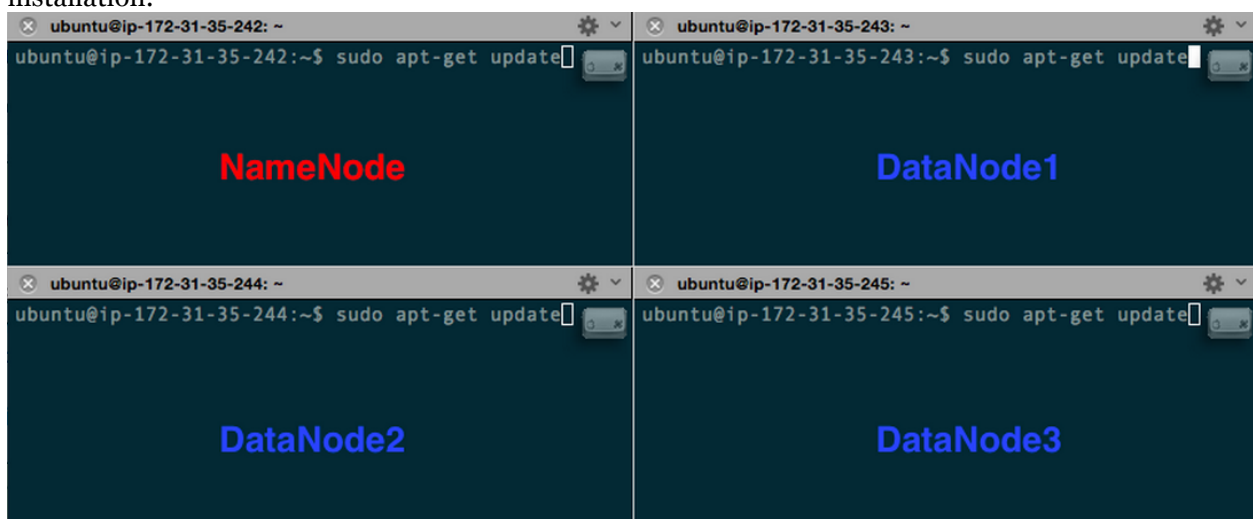
```
namenode$ cat ~/.ssh/id_rsa.pub | ssh datanode1 'cat >> ~/.ssh/authorized_keys'
namenode$ cat ~/.ssh/id_rsa.pub | ssh datanode2 'cat >> ~/.ssh/authorized_keys'
namenode$ cat ~/.ssh/id_rsa.pub | ssh datanode3 'cat >> ~/.ssh/authorized_keys'
```

We can check this by trying to SSH into any of the DataNodes from the NameNode. You may still be prompted if you are sure you want to connect, but there should be no password requirement.

```
namenode$ ssh ubuntu@datanode1_public_dns
```

Install Hadoop

Now that password-less SSH is setup, we can begin installation of Hadoop and modify common configurations across the NameNode and DataNodes. Typically this is easier to do when you have 4 terminals open with each terminal representing a node. Below shows an example. If you're using iTerm2 or Terminator, toggling the broadcast input to all panes can help reduce mistakes during installation.



On fresh AWS instances, Java is not installed. We will be installing the openjdk-7-jdk package to be used by Hadoop.

```
allnodes$ sudo apt-get update
allnodes$ sudo apt-get install openjdk-7-jdk
```

We can test to see if Java installed correctly with the following command

```
allnodes$ java -version
java version "1.7.0_79"
OpenJDK Runtime Environment (IcedTea 2.5.5) (7u79-2.5.5-0ubuntu0.14.04.2)
OpenJDK 64-Bit Server VM (build 24.79-b02, mixed mode)
```

Next we'll install Hadoop onto all the nodes by first saving the binary tar files to ~/Downloads and extracting it to the /usr/local folder.

```
allnodes$ wget http://apache.mirrors.tds.net/hadoop/common/hadoop-2.7.1/hadoop-2.7.1.tar.gz -P ~/Downloads
allnodes$ sudo tar zxvf ~/Downloads/hadoop-* -C /usr/local
allnodes$ sudo mv /usr/local/hadoop-* /usr/local/hadoop
```

Environment Variables

Now we'll need to add some Hadoop and Java environment variables to ~/.profile and source them to the current shell session.

~/.profile:

```
export JAVA_HOME=/usr
export PATH=$PATH:$JAVA_HOME/bin
export HADOOP_HOME=/usr/local/hadoop
export PATH=$PATH:$HADOOP_HOME/bin
export HADOOP_CONF_DIR=/usr/local/hadoop/etc/hadoop
```

Then load these environment variables by sourcing the profile

```
allnodes$ . ~/.profile
```

Hadoop Configurations

For a basic setup of Hadoop, we'll be changing a few of the configurations in the Hadoop directory defined now by `HADOOP_CONF_DIR` environment variable. All the current configuration changes will be applied to the NameNode and all the DataNodes. After these changes, we will apply configurations specific to the NameNode and DataNodes.

Here are the following files to focus on:

- `$HADOOP_CONF_DIR/hadoop-env.sh`
- `$HADOOP_CONF_DIR/core-site.xml`
- `$HADOOP_CONF_DIR/yarn-site.xml`
- `$HADOOP_CONF_DIR/mapred-site.xml` (This file currently does not exist in the default Hadoop installation, but a template is available. We'll make a copy of the template and rename it to `mapred-site.xml`)

Common Hadoop Configurations on all Nodes

Let's start with `$HADOOP_CONF_DIR/hadoop-env.sh`. Currently only root users can edit files in the Hadoop directory, but we'll change this after all configurations have been applied. To edit the configurations files, you can simply add a `sudo` before the text editor of your choice, for example

```
allnodes$ sudo vim $HADOOP_CONF_DIR/hadoop-env.sh
```

The only thing that needs changing is the location of `JAVA_HOME` in the file. Simply replace `{JAVA_HOME}` with `/usr` which is where Java was just previously installed.

`$HADOOP_CONF_DIR/hadoop-env.sh`:

```
# The java implementation to use.  
export JAVA_HOME=/usr
```

The next file to modify is the `$HADOOP_CONF_DIR/core-site.xml`. Here we will declare the default Hadoop file system. The default configuration is set to the localhost, but here we will want to specify the NameNode's public DNS on port 9000. Scroll down in the xml file to find the configurations tag and be sure to change the file to look like the following

`$HADOOP_CONF_DIR/core-site.xml`:

```
<configuration>  
  <property>  
    <name>fs.defaultFS</name>  
    <value>hdfs://namenode_public_dns:9000</value>
```

```
</property>
</configuration>
```

The next file to modify is the \$HADOOP_CONF_DIR/yarn-site.xml. Scroll down in the xml file to find the configurations tag and be sure to change the file to look like the following

\$HADOOP_CONF_DIR/yarn-site.xml:

```
<configuration>
<!-- Site specific YARN configuration properties -->
  <property>
    <name>yarn.nodemanager.aux-services</name>
    <value>mapreduce_shuffle</value>
  </property>
  <property>
    <name>yarn.nodemanager.aux-services.mapreduce.shuffle.class</name>
    <value>org.apache.hadoop.mapred.ShuffleHandler</value>
  </property>
  <property>
    <name>yarn.resourcemanager.hostname</name>
    <value>namenode_public_dns</value>
  </property>
</configuration>
```

The last configuration file to change is the \$HADOOP_CONF_DIR/mapred-site.xml. We will first need to make a copy of the template and rename it.

```
allnodes$ sudo cp $HADOOP_CONF_DIR/mapred-site.xml.template $HADOOP_CONF_DIR/mapred-
site.xml
```

Scroll down in the xml file to find the configurations tag and be sure to change the file to look like the following

\$HADOOP_CONF_DIR/mapred-site.xml:

```
<configuration>
  <property>
    <name>mapreduce.jobtracker.address</name>
    <value>namenode_public_dns:54311</value>
  </property>
  <property>
    <name>mapreduce.framework.name</name>
    <value>yarn</value>
  </property>
</configuration>
```

NameNode Specific Configurations

Now that all the common configurations are complete, we'll finish up the NameNode specific configurations. On the NameNode, all that remains are the following:

- adding hosts to /etc/hosts
- modifying the configurations in \$HADOOP_CONF_DIR/hdfs-site.xml
- defining the Hadoop master in \$HADOOP_CONF_DIR/masters
- defining the Hadoop slaves in \$HADOOP_CONF_DIR/slaves

Let's start with adding to the hosts file located under /etc/hosts. We will need to add each node's public DNS and hostname to the list. The hostname can be found with the following

```
allnodes$ echo $(hostname)
```

or by taking the first part of the private DNS (e.g. **ip-172-31-35-242**.us-west-2.compute.internal)

By default, 127.0.0.1 localhost is present, so we can add under it to look like the following (ignoring the IPv6 settings):

/etc/hosts:

```
127.0.0.1 localhost
namenode_public_dns namenode_hostname
datanode1_public_dns datanode1_hostname
datanode2_public_dns datanode2_hostname
datanode3_public_dns datanode3_hostname
# The following lines are desirable for IPv6 capable hosts
::1 ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ff02::3 ip6-allhosts
```

We can now modify the \$HADOOP_CONF_DIR/hdfs-site.xml file to specify the replication factor along with where the NameNode data will reside. For this setup, we will specify a replication factor of 3 for each data block in HDFS.

Scroll down in the xml file to find the configurations tag and be sure to change the file to look like the following

\$HADOOP_CONF_DIR/hdfs-site.xml:


```
<configuration>
  <property>
    <name>dfs.replication</name>
    <value>3</value>
  </property>
  <property>
    <name>dfs.namenode.name.dir</name>
    <value>file:///usr/local/hadoop/hadoop_data/hdfs/namenode</value>
  </property>
</configuration>
```

The current path where data on the NameNode will reside does not exist, so we'll need to make this before starting HDFS.

```
namenode$ sudo mkdir -p $HADOOP_HOME/hadoop_data/hdfs/namenode
```

Next we'll need to add a masters file to the \$HADOOP_CONF_DIR directory

```
namenode$ sudo touch $HADOOP_CONF_DIR/masters
```

then insert the NameNode's hostname in that file

\$HADOOP_CONF_DIR/masters:

```
namenode_hostname
```

We will also need to modify the slaves file in the \$HADOOP_CONF_DIR directory to the following. By default localhost is present, but we can remove this.

\$HADOOP_CONF_DIR/slaves

```
datanode1_hostname
datanode2_hostname
datanode3_hostname
```

Now that all configurations are set on the NameNode, we will change the ownership of the \$HADOOP_HOME directory to the user ubuntu

```
namenode$ sudo chown -R ubuntu $HADOOP_HOME
```

DataNode Specific Configurations

Let's now move onto the final configurations for the DataNodes. We will need to first SSH into each DataNode and only configure the `$HADOOP_CONF_DIR/hdfs-site.xml` file

Scroll down in the xml file to find the configurations tag and be sure to change the file to look like the following

`$HADOOP_CONF_DIR/hdfs-site.xml`:

```
<configuration>
  <property>
    <name>dfs.replication</name>
    <value>3</value>
  </property>
  <property>
    <name>dfs.datanode.data.dir</name>
    <value>file:///usr/local/hadoop/hadoop_data/hdfs/datanode</value>
  </property>
</configuration>
```

Just like on the NameNode, we will need to create the directory specified in the `$HADOOP_CONF_DIR/hdfs-site.xml` file.

```
datanodes$ sudo mkdir -p $HADOOP_HOME/hadoop_data/hdfs/datanode
```

Now that all configurations are set on the DataNode, we will change the ownership of the `$HADOOP_HOME` directory to the ubuntu user

```
datanodes$ sudo chown -R ubuntu $HADOOP_HOME
```

Start Hadoop Cluster

We can now start up HDFS from the Namenode by first formatting it and then starting HDFS. An important thing to note is that every time the NameNode is formatted, all of the data previously on it is lost.

```
namenode$ hdfs namenode -format
namenode$ $HADOOP_HOME/sbin/start-dfs.sh
```

When asked “The authenticity of host ‘Some Node’ can’t be established. Are you sure you want to continue connecting (yes/no)?” type yes and press enter. **You may need to do this several times — keep typing yes, then enter, even if there is no new prompt**, since it’s the first time for Hadoop to log into each of the Datanodes.

You can go to **namenode_public_dns:50070** in your browser to check if all Datanodes are online. If the webUI does not display, check to make sure your EC2 instances have security group settings that include All Traffic and not just SSH. You should see 3 live nodes, otherwise there was an error in the previous steps.

Summary

Security is off.

Safemode is off.

1 files and directories, 0 blocks = 1 total filesystem object(s).

Heap Memory used 58.57 MB of 186 MB Heap Memory. Max Heap Memory is 889 MB.

Non Heap Memory used 30.46 MB of 31.94 MB Committed Non Heap Memory. Max Non Heap Memory is 214 MB.

Configured Capacity:	23.22 GB
DFS Used:	72 KB
Non DFS Used:	6.17 GB
DFS Remaining:	17.05 GB
DFS Used%:	0%
DFS Remaining%:	73.44%
Block Pool Used:	72 KB
Block Pool Used%:	0%
DataNodes usages% (Min/Median/Max/stdDev):	0.00% / 0.00% / 0.00% / 0.00%
Live Nodes	3 (Decommissioned: 0)
Dead Nodes	0 (Decommissioned: 0)
Decommissioning Nodes	0

Now let’s start up YARN as well as the MapReduce JobHistory Server.

```
namenode$ $HADOOP_HOME/sbin/start-yarn.sh
namenode$ $HADOOP_HOME/sbin/mr-jobhistory-daemon.sh start historyserver
```

You can check to make sure all Java processes are running with the jps command on the NameNode and DataNodes (your process ids will be different though).

```
namenode$ jps
21817 JobHistoryServer
21853 Jps
21376 SecondaryNameNode
21540 ResourceManager
21157 NameNode
datanodes$ jps
20936 NodeManager
20792 DataNode
21036 Jps
```

Working with HDFS

You're now ready to start working with HDFS by SSH'ing to the NameNode. The most common commands are very similar to normal Linux File System commands, except that they are preceded by `hdfs dfs`. Below are some common commands and a few examples to get used to HDFS.

Common HDFS Commands

List all files and folder in directory

- `hdfs dfs -ls <folder name>`

Make a directory on HDFS

- `hdfs dfs -mkdir <folder name>`

Copy a file from the local machine (namenode) into HDFS

- `hdfs dfs -copyFromLocal <local folder or file name>`

Delete a file on HDFS

- `hdfs dfs -rm <file name>`

Delete a directory on HDFS

- `hdfs dfs -rmdir <folder name>`

HDFS Examples

```
# create local dummy file to place on HDFS
namenode$ echo "Hello this will be my first distributed and fault-tolerant data set\!"
| cat >> my_file.txt
```

```

# list directories from top level of HDFS
namenode$ hdfs dfs -ls /
# This should display nothing but a temp directory
# create /user directory on HDFS
namenode$ hdfs dfs -mkdir /user
namenode$ hdfs dfs -ls /
Found 1 items
drwxr-xr-x - ubuntu supergroup 0 2015-05-06 22:41 /user
# copy local file a few times onto HDFS
namenode$ hdfs dfs -copyFromLocal ~/my_file.txt /user
namenode$ hdfs dfs -copyFromLocal ~/my_file.txt /user/my_file2.txt
namenode$ hdfs dfs -copyFromLocal ~/my_file.txt /user/my_file3.txt
# list files in /user directory
namenode$ hdfs dfs -ls /user
Found 1 items
-rw-r - r - 3 ubuntu supergroup 50 2015-05-06 22:43 /user/my_file.txt
-rw-r - r - 3 ubuntu supergroup 50 2015-05-06 22:43 /user/my_file2.txt
-rw-r - r - 3 ubuntu supergroup 50 2015-05-06 22:43 /user/my_file3.txt
# clear all data and folders on HDFS
namenode$ hdfs dfs -rm /user/my_file*
15/05/06 22:49:06 INFO fs.TrashPolicyDefault: Namenode trash configuration: Deletion
interval = 0 minutes, Emptier interval = 0 minutes.
Deleted /user/my_file.txt
15/05/06 22:49:06 INFO fs.TrashPolicyDefault: Namenode trash configuration: Deletion
interval = 0 minutes, Emptier interval = 0 minutes.
Deleted /user/my_file2.txt
15/05/06 22:49:06 INFO fs.TrashPolicyDefault: Namenode trash configuration: Deletion
interval = 0 minutes, Emptier interval = 0 minutes.
Deleted /user/my_file3.txt
namenode$ hdfs dfs -rmdir /user

```

What Next?

Now that you have installed Hadoop, you can start running example MapReduce jobs found in the `$HADOOP_HOME/share/hadoop/mapreduce/` folder. The jar file is named `hadoop-mapreduce-examples-*.jar` and further documentation on using the jar file can be found here, [Hadoop MapReduce Examples](#).

If writing MapReduce in Java isn't your cup of tea, you can also look at higher abstractions such as Pig and Hive to run jobs on your dataset in HDFS.

While running any MapReduce job you can monitor each job by going to port 8088 on the NameNode



Nodes of the cluster

Logged in as: dr.who

Cluster

About Nodes ApplicationsNEW SUBMITTED ACCEPTED RUNNING FINISHED FAILED KILLED SchedulerTools

Cluster Metrics

Apps Submitted	Apps Pending	Apps Running	Apps Completed	Containers Running	Memory Used	Memory Total	Memory Reserved	VCores Used	VCores Total	VCores Reserved	Active Nodes	Decommissioned Nodes	Lost Nodes	Unhealthy Nodes	Rebooted Nodes
2	0	0	2	0	0 B	24 GB	0 B	0	24	0	3	0	0	0	0

Show 20 entries

Search:

Node Labels	Rack	Node State	Node Address	Node HTTP Address	Last health-update	Health-report	Containers	Mem Used	Mem Avail	VCores Used	VCores Avail	Version
/default-rack		RUNNING	ip-172-31-42-158.us-west-2.compute.internal:53766	ip-172-31-42-158.us-west-2.compute.internal:8042	20-May-2015 21:08:18		0	0 B	8 GB	0	8	2.6.0
/default-rack		RUNNING	ip-172-31-42-156.us-west-2.compute.internal:32933	ip-172-31-42-156.us-west-2.compute.internal:8042	20-May-2015 21:08:18		0	0 B	8 GB	0	8	2.6.0
/default-rack		RUNNING	ip-172-31-42-157.us-west-2.compute.internal:37537	ip-172-31-42-157.us-west-2.compute.internal:8042	20-May-2015 21:08:18		0	0 B	8 GB	0	8	2.6.0

Showing 1 to 3 of 3 entries

First Previous 1 Next Last

and you can see the history of jobs run on Hadoop at **namenode_public_dns:19888**



JobHistory

Logged in as: dr.who

Application		Retired Jobs														
About Jobs Tools		Showing 1 to 2 of 2 entries														
		Search:														
		Submit Time	Start Time	Finish Time	Job ID	Name	User	Queue	State	Maps Total	Maps Completed	Reduces Total	Reduces Completed			
		2015.05.20 20:57:22 UTC	2015.05.20 20:57:26 UTC	2015.05.20 21:00:25 UTC	job_1432154296691_0002	PigLatin:price_data.pig	ubuntu	default	SUCCEEDED	9	9	1	1			
		2015.05.20 20:40:43 UTC	2015.05.20 20:40:49 UTC	2015.05.20 20:43:36 UTC	job_1432154296691_0001	PigLatin:price_data.pig	ubuntu	default	SUCCEEDED	9	9	1	1			
		Submit Time	Start Time	Finish Time	Job ID	Name	User	Queue	State	Maps Total	Maps Completed	Reduces Total	Reduces Completed			

When you are finished with your instances, be sure to shut them down or you may start incurring charges from AWS for the month

To terminate instances when you are finished with them, you can go to AWS Console and find the Instances tab along the left panel. Next highlight the instances you wish to terminate and click on Actions -> Instance State -> Terminate

Final Thoughts

These types of development setups have helped Insight Fellows hit the ground running and explore various distributed technologies beyond Hadoop such as [Kafka](#), [Spark](#), Storm, Elasticsearch, and [Cassandra](#). Although setting up these systems are not the primary concerns for data engineers, understanding how distributed systems are installed and connected is still a valuable skill.