Spinning up an Apache Spark Cluster: Step-by-Step

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The DevOps series covers how to get started with the leading open source distributed technologies. In this tutorial, we step through how to deploy a Spark Standalone cluster on AWS for less than $1. In a follow up post, we will show you how to use a Jupyter notebook on Spark for ad hoc analysis of Reddit comment data on Amazon S3.

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.

This following tutorial shows how you can deploy your own Spark cluster in standalone mode on top of Hadoop. Due to Spark's memory demand, we recommend using m4.large spot instances with 200GB of magnetic hard drive space each.

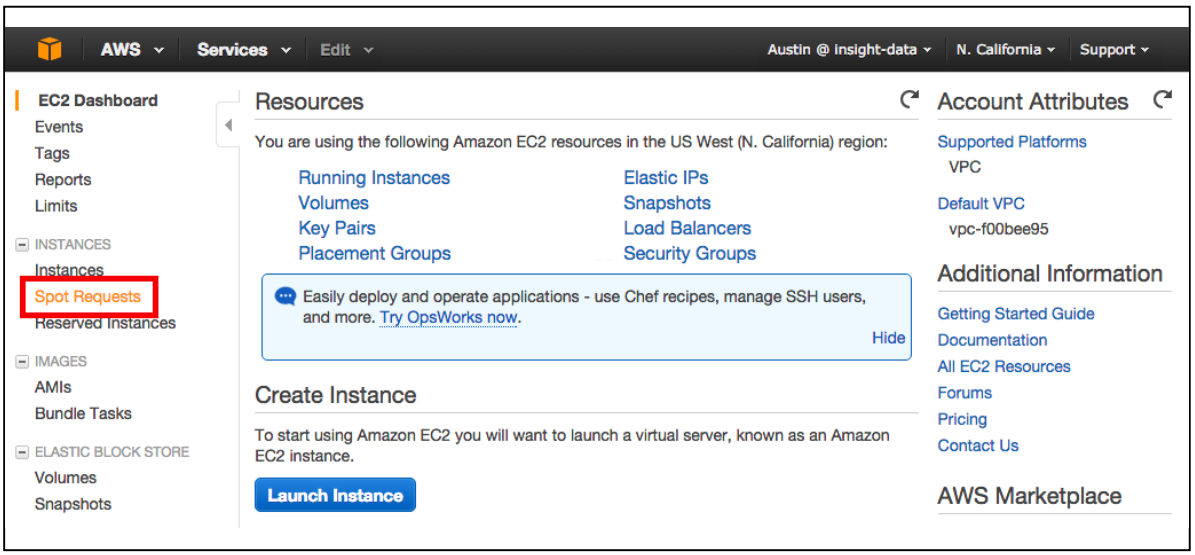
m4.large spot instances are not within the free-tier package on AWS, so this tutorial will incur a small cost. The tutorial should not take any longer than a couple hours, but if we allot 6 hours for your 4 node spot cluster, the total cost should run around $0.69 depending on the region of your cluster. If you run this cluster for an entire month we can look at a bill of around $80, so be sure to spin down you cluster after you are finished using it.

Spark Introduction

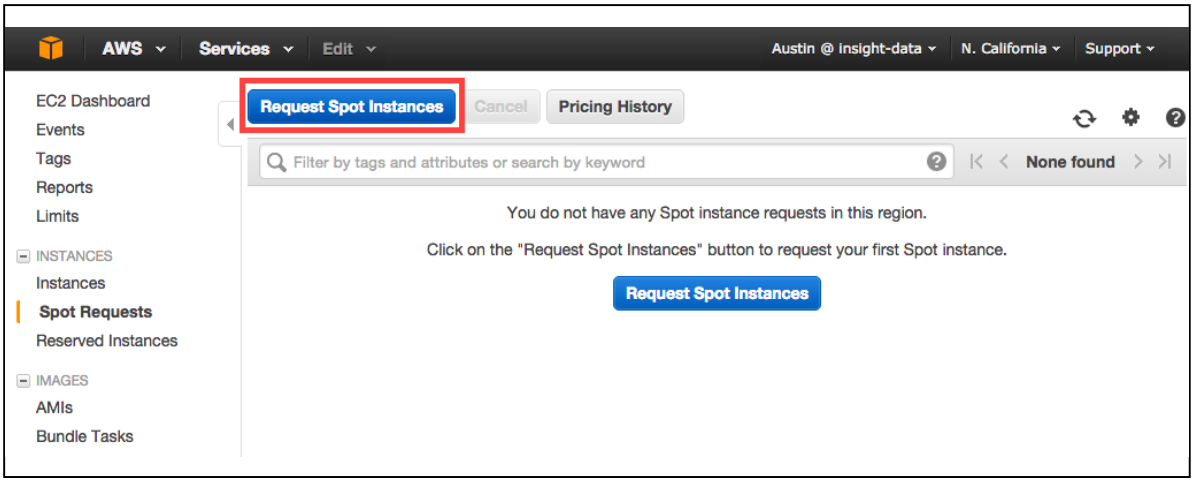
Spark is a general computation engine that uses distributed memory to perform fault-tolerant computations with a cluster. Even though Spark is relatively new, it is one of the hottest open-source technologies at the moment and has begun to surpass Hadoop's MapReduce model. This is partly because Spark's Resilient Distributed Dataset (RDD) model can do everything the MapReduce paradigm can, and more. In addition, Spark can perform iterative computations at scale, which opens up the possibility of executing machine learning algorithms (with Spark MLlib) much faster than with Hadoop alone.

Spinning up AWS EC2 Spot Instances

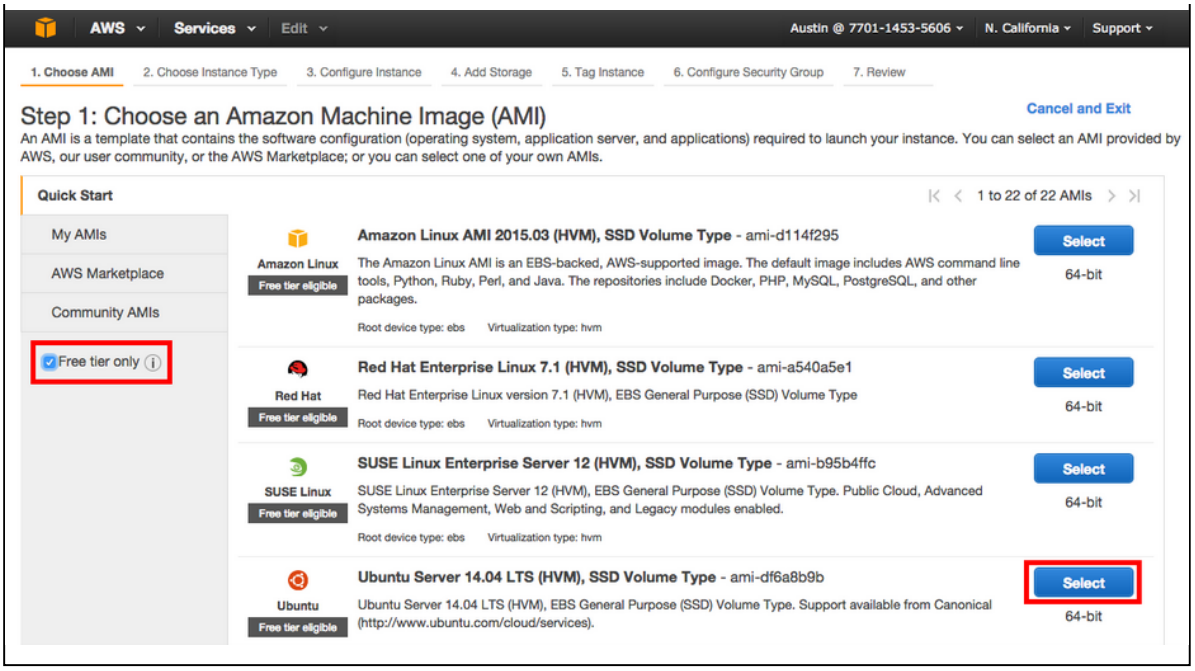
Spot instances are great for reducing AWS costs sometimes cutting instance costs by a whole order of magnitude. The tradeoff is that you can lose the instances at any time if the demand for a specific instance type increases past your bid price. Spinning a spot instance for this tutorial is just as easy as on-demand instances. In your AWS EC2 dashboard, you will need to click on Spot Requests instead of Instances.



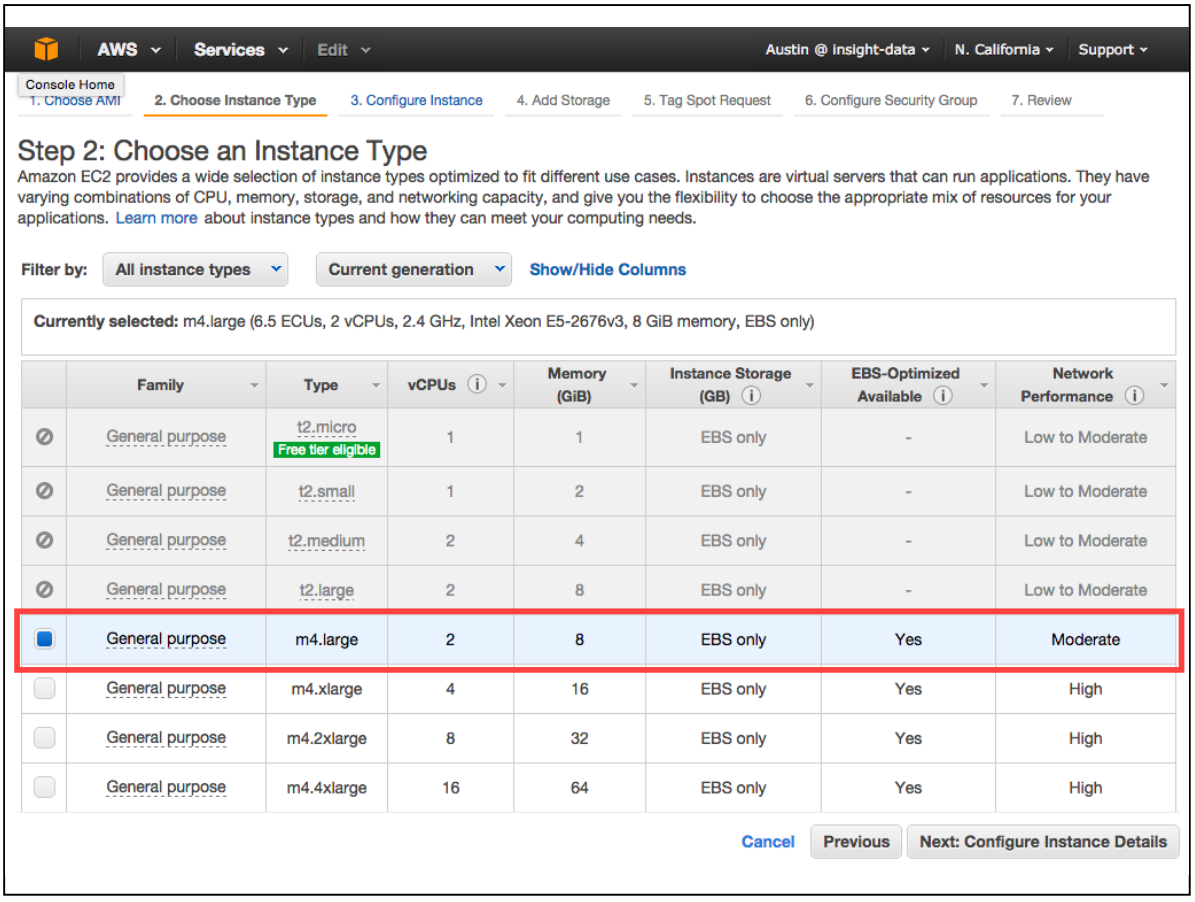
Next request the spot instances.



We will be using the Ubuntu 14.04 AMI.

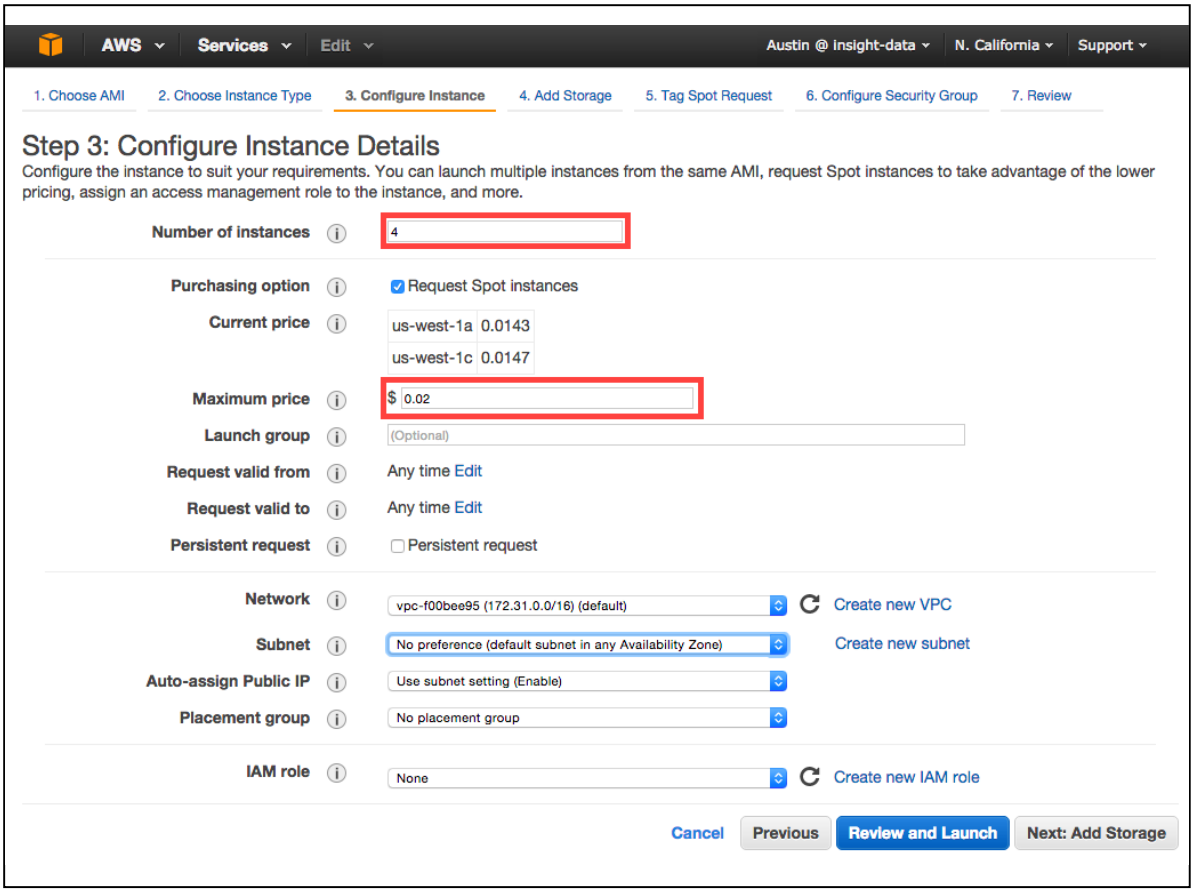


Next select the type of instance you would like to spin up. The minimum is m4.large which is what we will use for this tutorial.

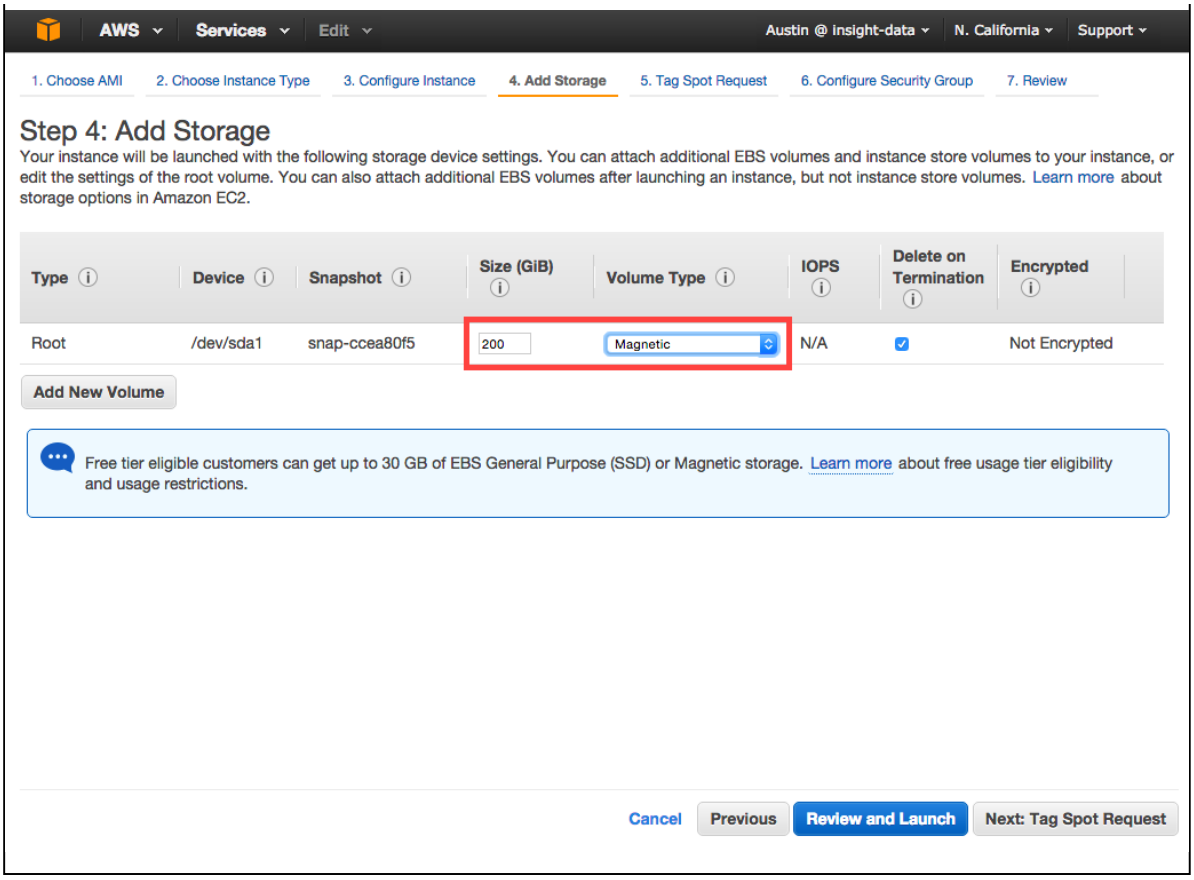


Moving on to the spot instance details, set the number of instances to 4 and the maximum price to $0.02. In general if you place a maximum price about 50% higher

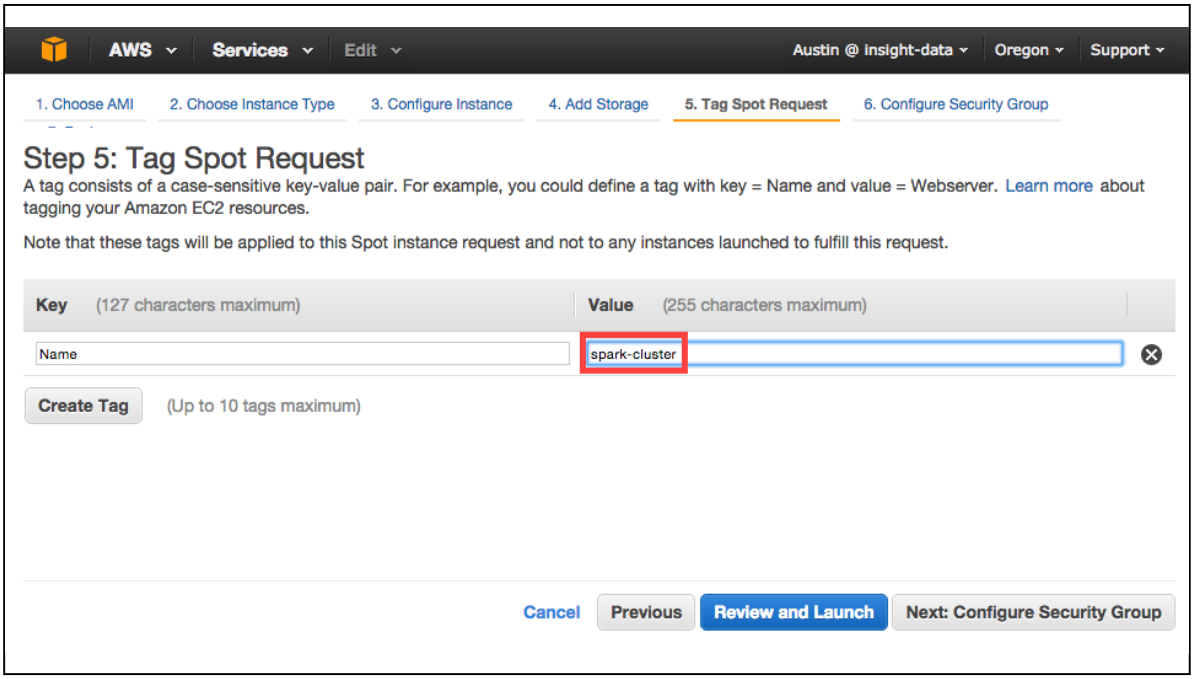
than the current price, you should not have instances terminate that often.



For this tutorial we will also bump up the storage space per instance to 200GB. Choosing the magnetic option can help cut down costs, but have worse read and write performance than SSDs.

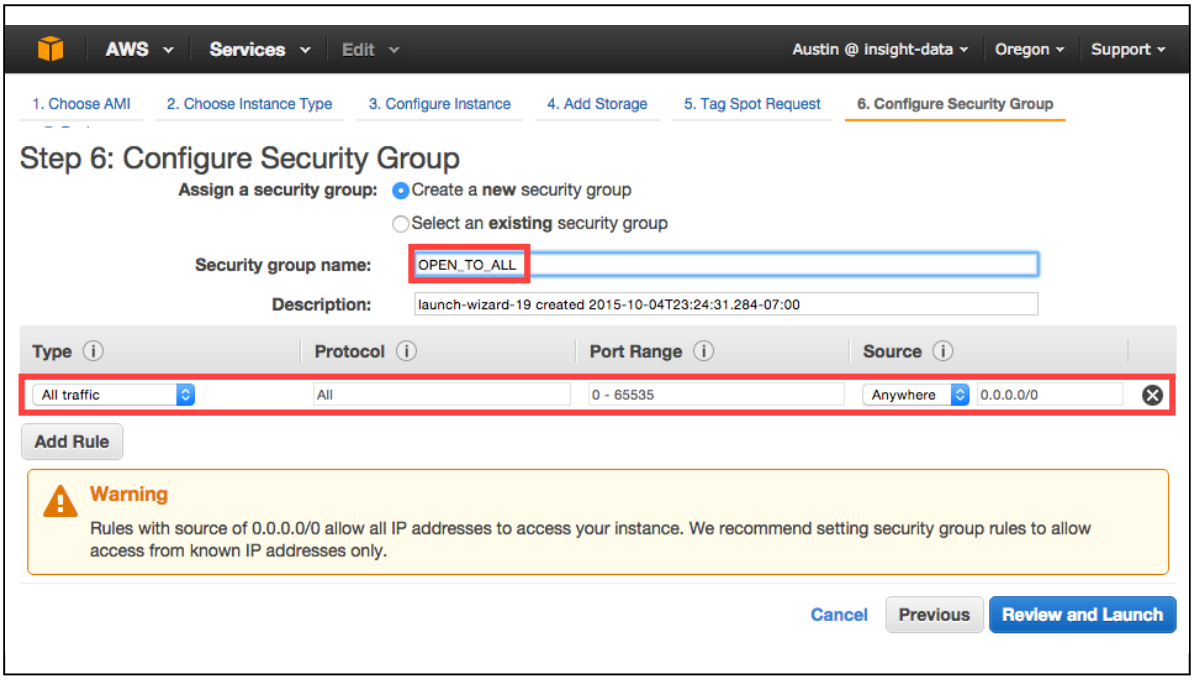


Next name your instances.

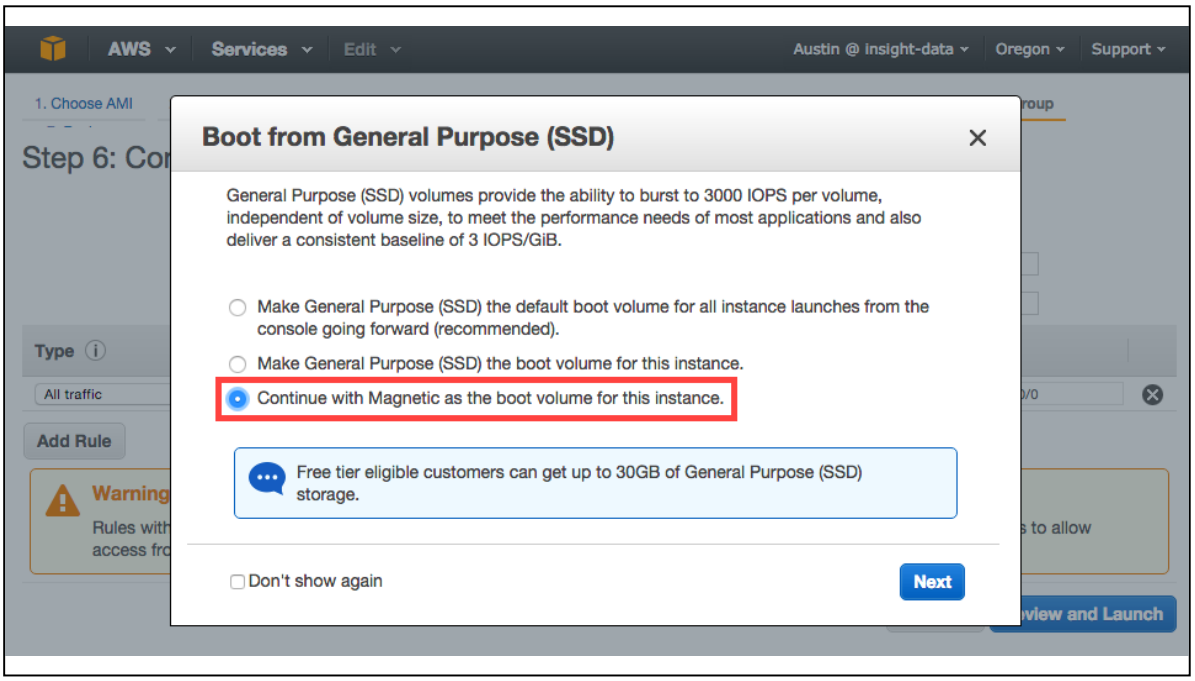


The next step will configure the security groups setting for these spot instances. All the ports are open for simplicity, but it should be noted that these settings should be

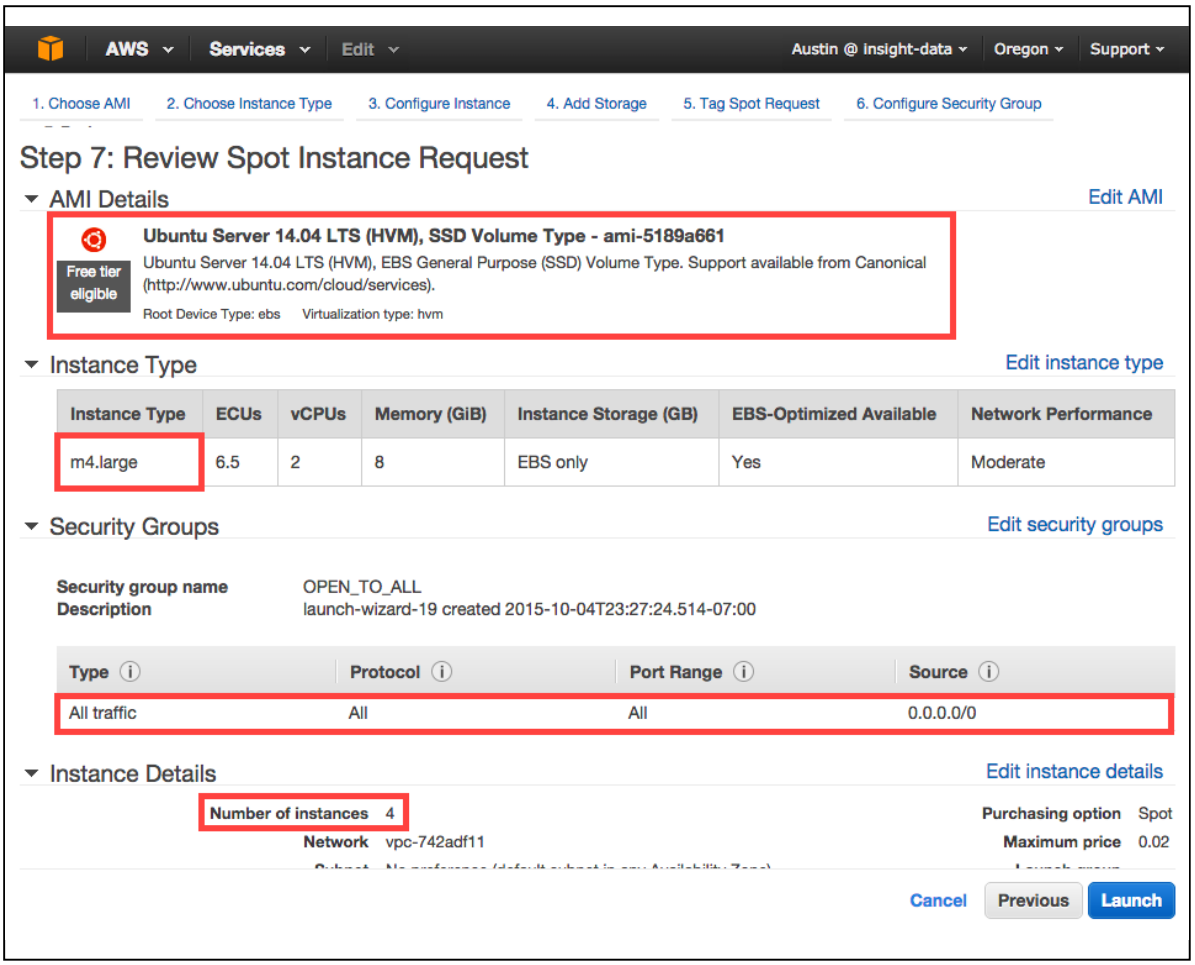
much more strict if put in production. If a security group does not exist with the following configuration, you can create a new security group with the following settings.



You will then be asked to choose which option for your instances' boot volume. Choose the magnetic option.



The final step will let you review your configurations before launching. Be sure that the AMI, instance type, security groups, and number of instances are correct.



Install Hadoop

Spark uses several dependencies from Hadoop. In case you have not installed Hadoop on your cluster, please do so from our Hadoop DevOps post before proceeding.

Install Spark

We will be using our Hadoop NameNode to act as our Spark Master and the remaining Hadoop DataNodes as Spark Workers. We will first install Spark on all the nodes and then configure the Spark Master. We recommend having 4 terminals open with each terminal representing a node. If you are using iTerm2, toggling the broadcast input to all panes can help reduce mistakes during installation.

We assume Java has been previously installed. You can check for this with the following command

```
allnodes$ java -version
java version "1.7.0_79"
OpenJDK Runtime Environment (IcedTea 2.5.6) (7u79-2.5.6-0ubuntu1.14.04.1)
OpenJDK 64-Bit Server VM (build 24.79-b02, mixed mode)
```

Install Scala with the following:

```
allnodes$ sudo apt-get install scala
```

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

```
allnodes$ scala -version

Scala code runner version 2.9.2 -- Copyright 2002-2011, LAMP/EPFL
```

Next install Spark 1.4.1 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/spark/spark-1.4.1/spark-
1.4.1-bin-hadoop2.4.tgz -P ~/Downloads
allnodes$ sudo tar zxvf ~/Downloads/spark-* -C /usr/local
allnodes$ sudo mv /usr/local/spark-* /usr/local/spark
```

Environment Variables

Now add the Spark environment variables to `~/.profile` and source it to the current shell session.

~/.profile

```
export SPARK_HOME=/usr/local/spark

export PATH=$PATH:$SPARK_HOME/bin
```

Then load these environment variables by sourcing the profile:

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

Change the ownership of the `$SPARK_HOME` directory to the user ubuntu:

```
allnodes$ sudo chown -R ubuntu $SPARK_HOME
```

Spark Configurations

For a basic setup of Spark, we will create a Spark configuration file using the existing template that comes with Spark. All the current configuration changes will be applied to the Spark Master node and all the Spark Worker nodes. After these changes, we will apply configurations specific to the Spark Master node.

Common Spark Configurations on all Nodes

The only file to focus on is the `$SPARK_HOME/conf/spark-env.sh`. First make a copy of the template and rename it:

```
allnodes$ cp $SPARK_HOME/conf/spark-env.sh.template
$SPARK_HOME/conf/spark-env.sh
```

The entire file should be commented out, so we can insert our configurations wherever we would like. For now insert them near the beginning as shown below:

$SPARK_HOME/conf/spark-env.sh

```
#!/usr/bin/env bash


# This file is sourced when running various Spark programs.
# Copy it as spark-env.sh and edit that to configure Spark for your site.


export JAVA_HOME=/usr
export SPARK_PUBLIC_DNS="current_node_public_dns"
export SPARK_WORKER_CORES=6
…
…
…
```

We have chosen `SPARK_WORKER_CORES` to be 6 based on the instances that we are using for this example cluster setup. In general, this variable defines the amount of parallelism each Spark Worker node has. The variable `SPARK_WORKER_CORES` can be misleading, since it does not represent the number of physical cores on your Spark Worker machine. Instead it represents the number of Spark tasks (or threads) a Spark Worker can give to its Spark Executors.

Our Spark Worker nodes are m4.large instances containing 2 CPU cores. Assuming that only one Spark Executor is spawned by the Spark Worker, this means that at most 6 Spark tasks can be distributed amongst the 2 CPUs for one Spark Application at any given time. Here we are oversubscribing by a factor of 3. By default, if this

value is not set, there will be no oversubscription of Spark Worker Cores (Spark task slots). In most cases you should always oversubscribe by at least a factor of 2 and will typically see a significant performance benefit.

Spark Master Specific Configurations

Now that all the common configurations are complete, we will finish up the Spark Master specific configurations. Create a slaves file in the Spark configuration folder which will contain the public DNS's of all the Spark Worker nodes:

```
spark_master_node$ touch $SPARK_HOME/conf/slaves
```

$SPARK_HOME/conf/slaves

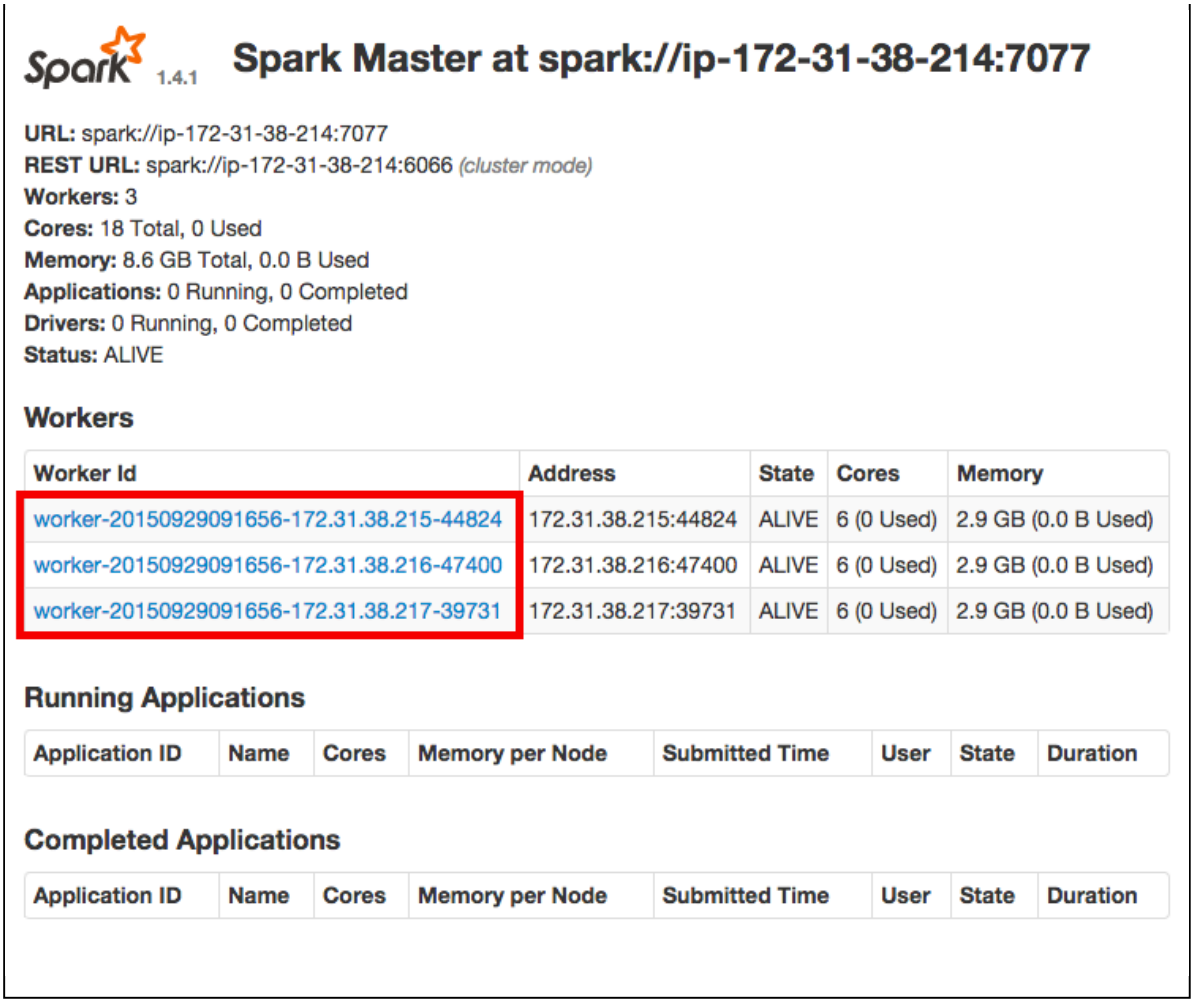
```
spark_worker1_public_dns
spark_worker2_public_dns
spark_worker3_public_dns
```

Start Your Spark Cluster

We can now start up the Spark cluster from the Spark Master node

```
spark_master_node$ $SPARK_HOME/sbin/start-all.sh
```

You can go to `spark_master_public_dns:8080` in your browser to check if all Worker nodes 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.



Next Steps

Now that you have a working Spark cluster you can start creating your own RDDs, performing operations on RDDs, and reading and writing to HDFS, S3, Cassandra or many other distributed file systems and databases. In our next tutorial, we will show you how to install the Jupyter notebook on your Spark cluster and use it to process Reddit comment data residing on S3. Sign up to our mailing list to be the first to get this and future tutorials.

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