

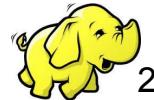
INSIGHT

What's inside ?

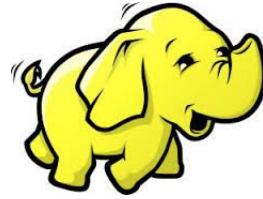
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BIG DATA



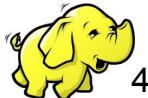
DATA IS THE NEW OIL

What is Big Data ?

Any system which dictates the necessity of one 'V' said below

A big data environment has one or more of the following characteristics : Volume, Velocity, Variety and Veracity.

Volume	Facebook generates 500 TB/day
Velocity	One million events per second
Variety	Geospatial Data, Audio, Video data etc..,
Veracity	Data in doubt. Uncertainty due to data inconsistency and incompleteness.



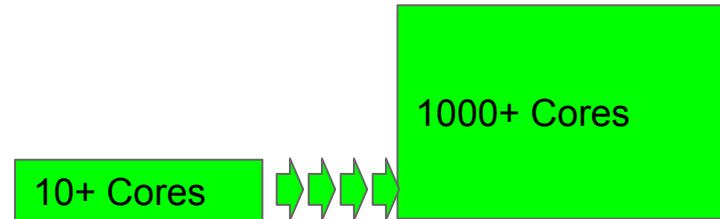
Current trends in Big Data

Facebook 350 millions images uploaded every day.

Walmart 2.5 PB of customer data hourly.

Youtube 300 hours of video uploaded every minute.

The world of high CPU and GPU.



Data unit measurement

Bit	1 Bit
Byte	8 Bits
KiloByte	1024 bytes
MegaByte	1024 Kilobytes
Gigabyte	1024 Megabytes
Terabyte	1024 Gigabytes
Petabyte	1024 Terabytes
Exabyte	1024 Petabytes
Zettabyte	1024 Exabytes
Yottabyte	1024 Zettabytes
Bronabyte	1024 Yottabytes
Geopbyte	1024 Bronabytes

AADHAAR data is approximately 10 PB.

A gram of DNA will be around 450 exabytes.

In 2013, approximately the WWW has reached around 4 zettabytes.

Why Big Data now ?

SmartPhones, connectivity with Internet/ IoT (Internet of Things), Social Networks etc.., has generated tons of data. Moreover the devices used for accessing became cheaper, faster and smaller.

This made the data manipulation a challenge paving way for a new trend of data management called - The Big Data.

If one ox can plough a field of 1 acre of land and if a requirement pops up to plough a 10 acre land, you cannot grow an ox that is 10 times big. Instead use 10 oxen to plough the 10 acre land and this phenomenon is basically done by any big data system.

Is 1 PB Big Data ?

It depends on what I am going to do with the one petabyte of data.

If i am not going to operate on at least few terabytes,
then there is no need for big data environment.

Types of Architectures in Big Data

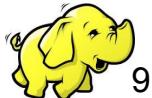
Lambda Architecture

Kappa Architecture

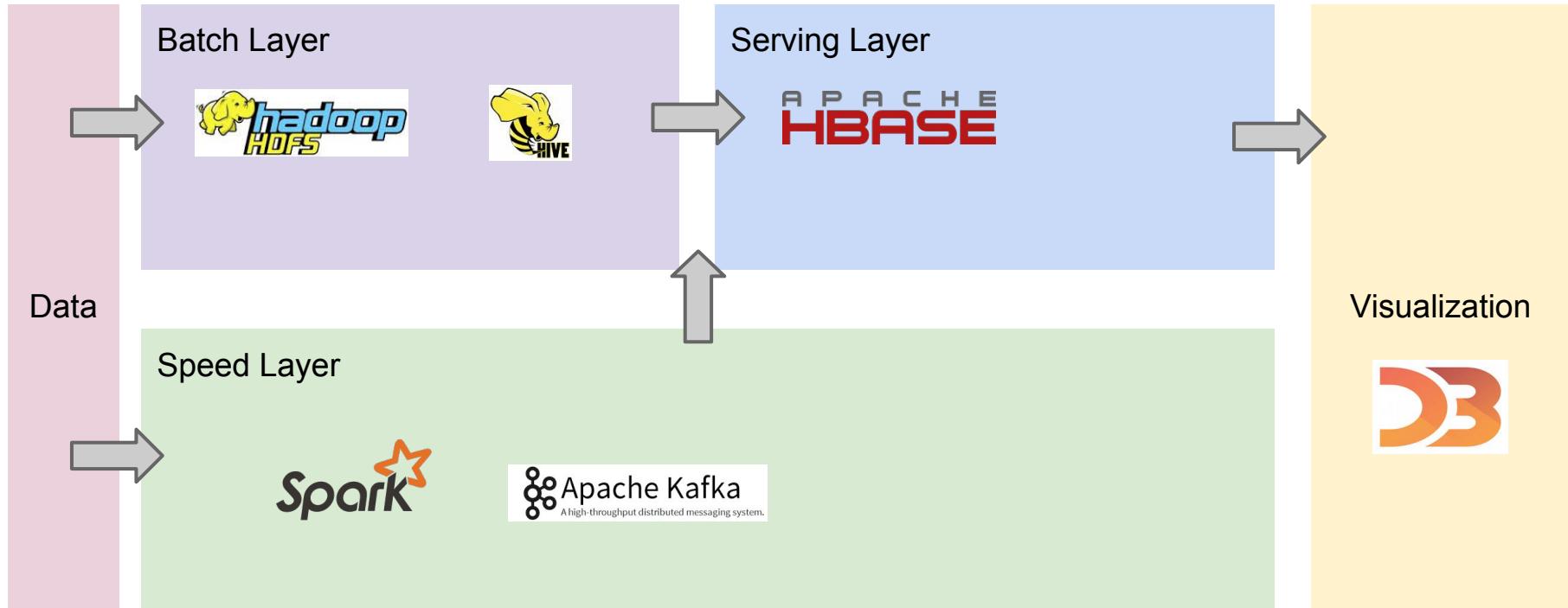
Staged Event Driven Architecture (SEDA)

Real Time Streaming Architecture

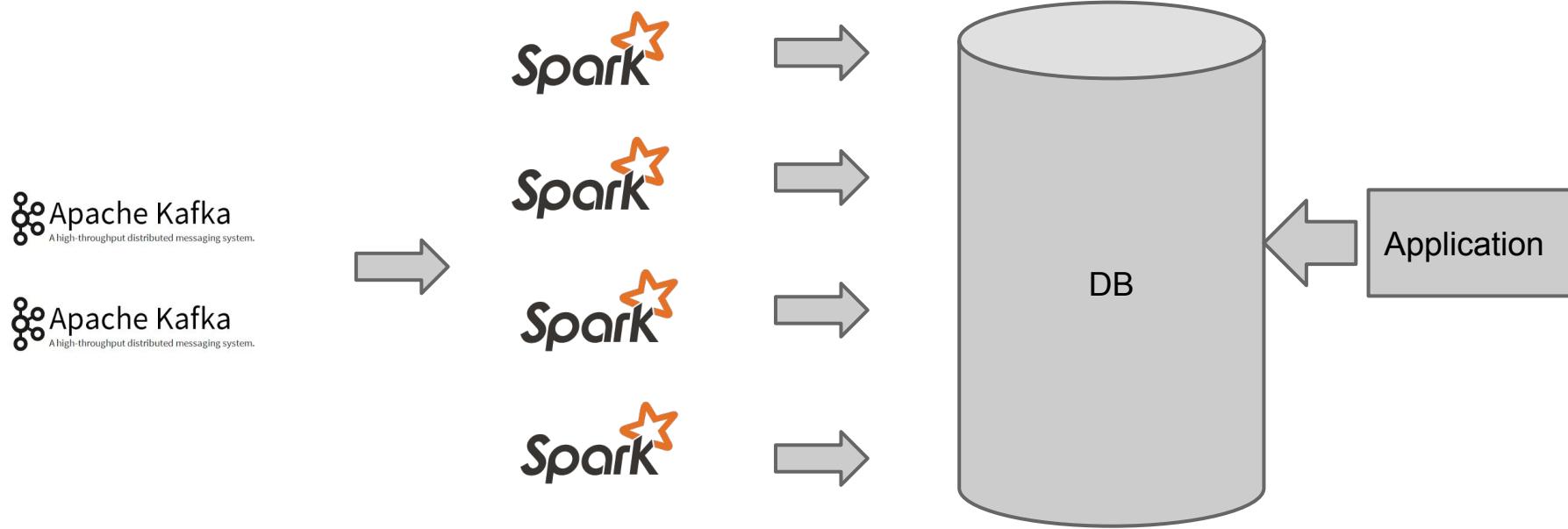
Zeta Architecture



Lambda Architecture



Kappa Architecture



SEDA Architecture

Staged Event Driven Architecture



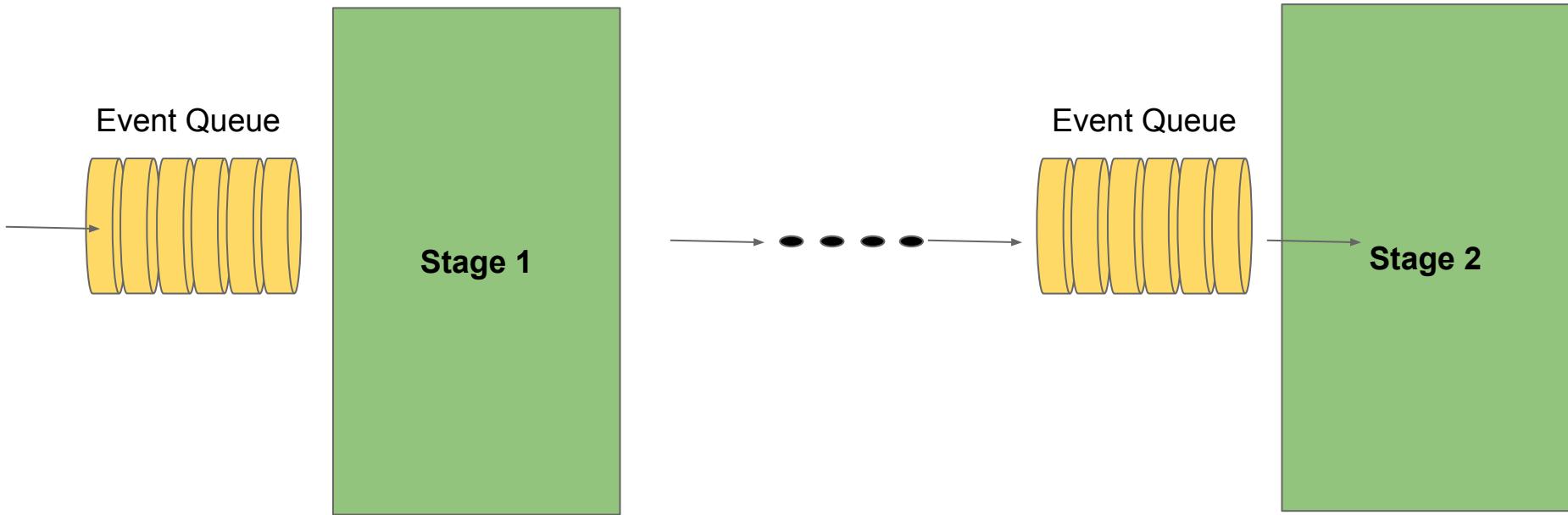
SEDA is a software design that decomposes a complex, event driven application into a set of stages connected by queues.

Every stage in SEDA is autonomous and connected to the next one by infrastructure and not by code.

All stages of the aadhaar are stateless and message driven in a request response model. Each stage is given complete data that it requires for execution.

SEDA Architecture

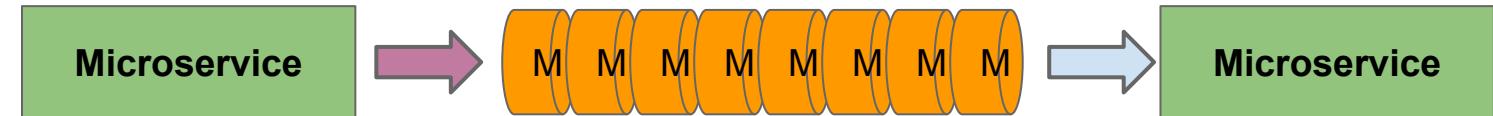
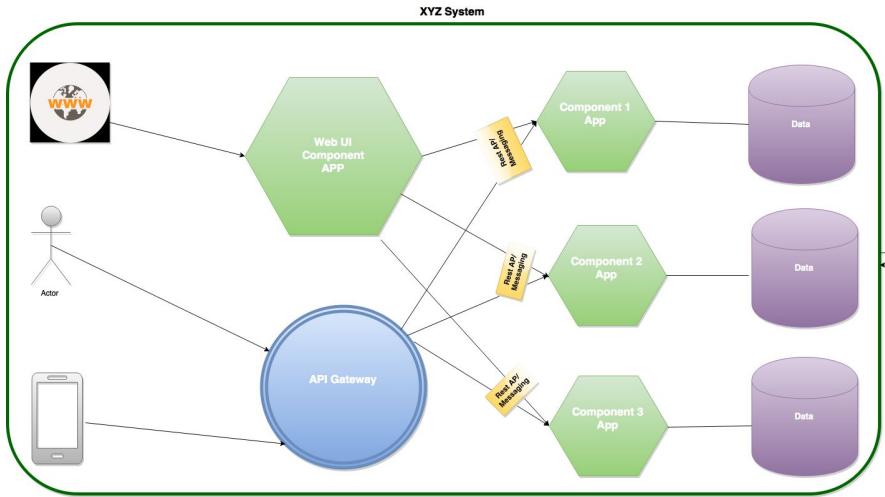
Staged Event Driven Architecture



Zeta Architecture



Microservices Architecture



Microservices Architecture

Use messaging instead of REST

Load balancing is easy

High throughput

Asynchronous by design

Messaging guarantees delivery

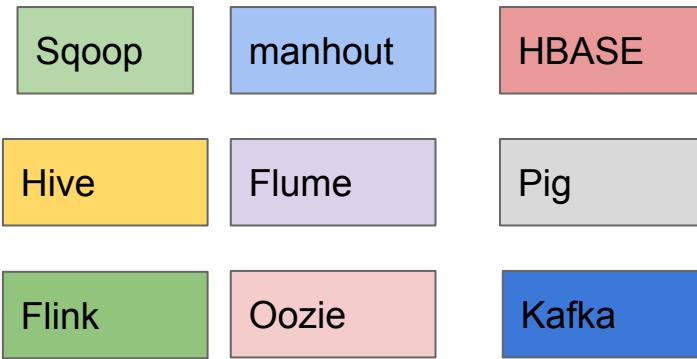
Myths of Big Data

Once a myth. Not anymore....

Will be the future : It's not the future, it is already the present

We will build it, when we need it : Never. If you can forecast your data size, start building it right now.

Hadoop Ecosystem



HDFS - Stores data in the cluster
Namenode - manages hdfs and the data

Mapreduce - process data in the cluster
JobTracker - manages Mapreduce



NoSQL Stores

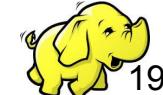
Aravindh Chinnasamy

Key-Value Store



Columnar Store

Document Store



CAP Theorem

C - Consistency

A - Availability

P - Partition Tolerance

Consistency : stating that all the nodes in the system see the same data at the same time.

Availability : stating every request receives the response.

Partition Tolerance : If any node fails, then the system continues to operate with the help of other nodes.

Cassandra, Voldemort is a AP system.

HBASE is a CP system.

Data Lakes

- [*] Nothing but a HDFS Implementation.
- [*] People also use Amazon S3.
- [*] Write everything, don't purge anything. Data is the King.
- [*] Corporations also use Enterprise Data Lakes for their organizations.
- [*] PERFECT FABRIC for the CLOUD



Messaging System

Kafka

RabbitMQ

ActiveMQ

ZeroMQ

Memcache - Redis comparison



An in-memory key-value store

Used for operating caches on small footprints of data, mostly strings

Simple LRU cache eviction policy

No replication support

An in-memory key-value store

Used for operating on heavy data structure objects.

Fine grained LRU cache policies

noeviction, allkeys-lru, volatile-lru, allkeys-random, volatile-random, volatile-ttl

Supports master-slave replication, which is a major advantage in a big data system.

Memcache - Redis comparison



Primary used for reducing the load on the database.

Used for key-value retrieval for all types of keys.

Limited key-name size

Comparatively larger key-size when compared to memcache.

Cannot store data to disk.

Optional and tunable data persistence.

Parallel Threads

```
final ForkJoinPool forkJoinExecutor = new ForkJoinPool  
    (Runtime.getRuntime().availableProcessors());  
  
final Object[] destination = new Object[inputList.size ()];  
  
final ComponentTask<X, Y> action = new ComponentTask<> (  
    inputList, destination, function, 0, inputList.size () - 1);  
  
forkJoinExecutor.invoke (action);  
  
final List<Y> resultList = new ArrayList (destination.length);  
  
for (final Object o : destination) {  
    @SuppressWarnings ("unchecked") final Y y = (Y) o;  
    resultList.add (y);
```

Parallel Threads

```
public class ComponentTask<X, Y> extends RecursiveAction {  
}
```

```
import java.util.concurrent.ForkJoinTask;  
import java.util.concurrent.RecursiveAction;  
import java.util.function.Function;
```

Parallel Threads

```
@Override  
    protected void compute () {  
  
        final int bracketSize = (this.end - this.start);  
  
        if (bracketSize < MINIMUM_THRESHOLD) {  
  
            this.computeFully ();  
  
        } else {  
  
            final int middle = this.start + (bracketSize  
/ 2);  
  
            final ComponentTask<X, Y> firstSubtask = new  
ComponentTask<> (this.list,  
                           this.destination,  
                           this.function,  
                           this.start);
```

Parallel Threads

```
/**  
 * Do the computation directly.  
 */  
private void computeFully () {  
  
    for (int i = this.start; i <= this.end; i++) {  
        final Y result = this.function.apply (this.list.get  
(i));  
        this.destination[i] = result;  
    }  
}
```

Hadoop - HDFS



What is Hadoop ?

Hadoop is the open source implementation of GFS (Google File System) and MR (MapReduce) concept of Google.

Hadoop is a open source, distributed data storage and processing framework built on commodity hardware that makes economics of unstructured data attractive.

Doug Cutting and Mike Cafarella were the creators of hadoop.

Hadoop was the name of Doug Cutting son's toy elephant.

How hadoop came into existence

2003 - Google releases papers with GFS (Google File System)

2004 - Google releases papers with MapReduce

2005 - Nutch used GFS and MapReduce to perform operations

2006 - Yahoo! created Hadoop based on GFS and MapReduce (with Doug Cutting and team)

2007 - Yahoo started using Hadoop on a 1000 node cluster

2008 - Apache took over Hadoop

2009 - Hadoop successfully sorted a petabyte of data in less than 17 hours to handle billions of searches and indexing millions of web pages.

2011 - Hadoop releases version 1.0

2013 - Version 2.0.6 is available

Hadoop Distributions

cloudera

Pivotal®

MAPR®



Hortonworks

HDFS

HDFS stands for Hadoop Distributed File System

It is the file system distributed across the nodes of the cluster.

The data is replicated across the nodes, thereby giving the fault tolerant behavior.

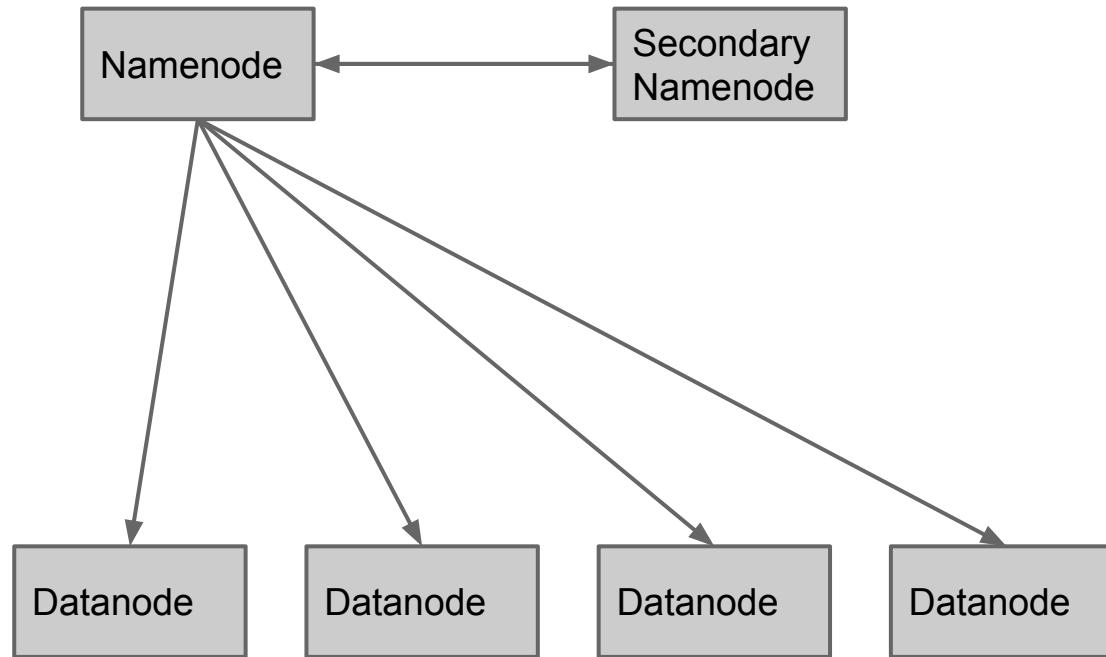
Namenode and Datanode

Namenode Node which contains pointers (references) to data

Datanode Node which contains the data.

Secondary namenode Failsafe node for the namenode.

Namenode and Datanode



Namenode

Namenode: The namenode stores metadata of hdfs.

The state of the hdfs is stored in a file called *fsimage*.

During runtime updation, the modifications are written to an edit file called *edits*.

On the next startup of the namenode, the state is read from the fsimage and the changes in the edits are read written back to the fsimage.

Then after which the edits are cleared.

Checkpoint Namenode & Backup Node

The checkpoint namenode does the merging of fsimage and edits in the runtime.

The Backup node does the same functionality of checkpoint node but it synchronizes the namenode with the help of in-memory computation.

hdfs commands

```
$ hdfs namenode -format
```

```
$ hdfs dfsadmin -report
```

```
$ hdfs dfs -ls /data
```

```
$ hdfs dfs -cat /data/sshd/wordcount.txt
```

```
$ hdfs dfs -chmod -R 1777 /data/sshd/wordcount.txt
```

hadoop commands

```
$ ./hadoop fs -ls /
```

```
$ ./hadoop fs -mkdir /aravindh
```

```
$ ./hadoop fs -du /
```

hadoop commands

- appendToFile
- cat
- checksum
- chgrp
- chmod
- chown
- copyFromLocal
- copyToLocal
- count
- cp
- createSnapshot
- deleteSnapshot
- df
- du
- dus
- expunge
- find
- get
- getfacl
- getfattr
- getmerge
- help
- ls
- lsr
- mkdir
- moveFromLocal
- moveToLocal
- mv
- put
- renameSnapshot
- rm
- rmdir
- rmr
- setfacl
- setfattr
- setrep
- stat
- tail
- test
- text

Upload a file to hdfs

```
private static String HDFS_PATH = "hdfs://localhost:9000";  
  
Configuration conf = new Configuration();  
  
BufferedReader inputStream =null ;  
inputStream = new BufferedReader(new FileReader("/Users/tester/myfile.csv"));  
  
FileSystem hdfs = FileSystem.get( new URI( HDFS_PATH ), conf );  
Path file = new Path("/data/destination_file.csv");  
  
OutputStream os = hdfs.create( file);  
  
BufferedWriter br = new BufferedWriter( new OutputStreamWriter( os, "UTF-8" ) );  
  
String line = null;  
  
while ((line = inputStream.readLine()) != null) {  
    br.write(line);  
}  
  
br.close();  
hdfs.close();
```

Configuring HDFS

The config files core-site.html and hdfs-site.xml are in hadoop_installation `/etc/hadoop` directory.

Step 1: core-site.xml (in etc/hadoop)

Step 2: hdfs-site.xml (in etc/hadoop)

Step 3: `./hdfs namenode -format`

Step 4: `./start-dfs.sh`

core-site.xml

```
<configuration>

    <property>
        <name>hadoop.tmp.dir</name>
        <value>/Users/tester/hadoopdata</value>
    </property>

    <property>
        <name>fs.defaultFS</name>
        <value>hdfs://localhost:9000</value>
    </property>

</configuration>
```

hdfs-site.xml

```
<configuration>

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

    <property>
        <name>dfs.datanode.data.dir</name>
        <value>/Users/tester/hadoopdata/hdfs</value>
    </property>

</configuration>
```

Do namenode formatting and start hdfs

Goto hadoop_installation/bin

./hdfs namenode -format

Goto hadoop_installation/sbin

./start-dfs.sh

```
Mynenis-MacBook-Pro:hadoop koteshwar$ jps
8481 Jps
8118 DataNode
8218 SecondaryNameNode
8038 NameNode
Mynenis-MacBook-Pro:hadoop koteshwar$
```

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

Cloudera - HDFS URI

The cloudera URI is configured in the following location:

/etc/hadoop/conf.pseudo/core-site.xml

The URI is :

hdfs://quickstart.cloudera:8020

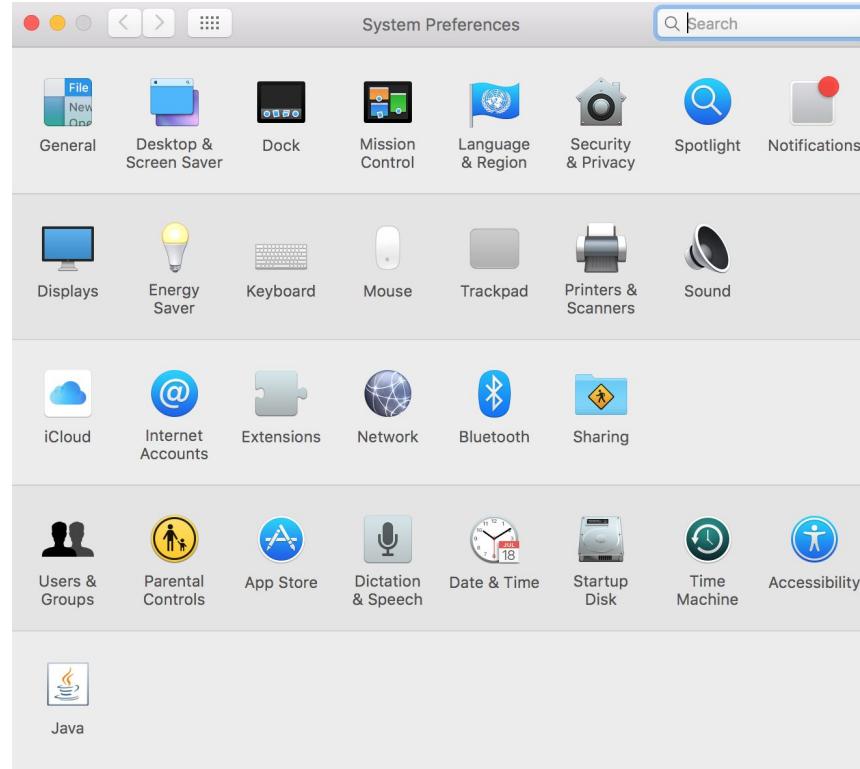
Do namenode formatting and start hdfs

`./start-dfs.sh`

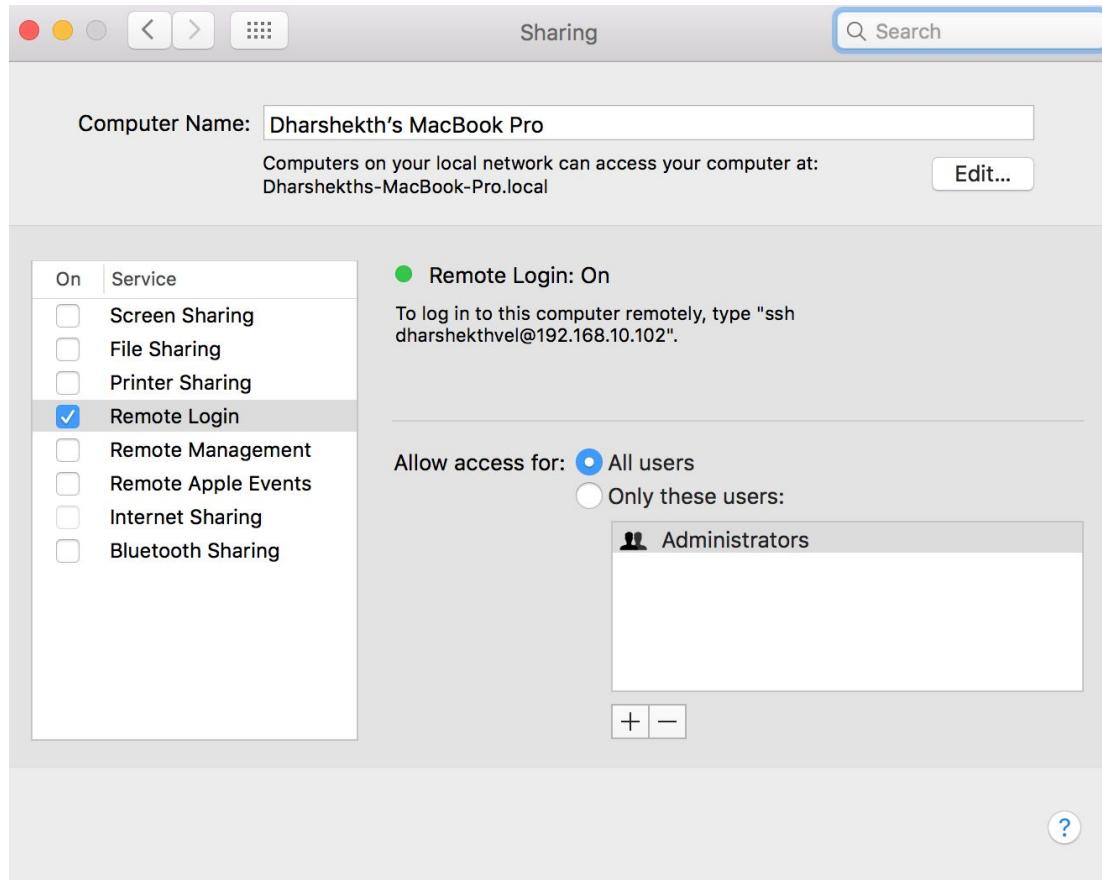
While starting hadoop with start-dfs.sh if you are getting error ensure, JAVA_HOME is set in hadoop-env.sh.

`/home/dharshekthvel/ac/bin/hadoop3/etc/hadoop/hadoop-env.sh`

To enable ssh in mac, go to **System Preferences**,
and click on **Sharing**.



Click on Remote Login and give access to All users.



```
SCHMAC-TESTER-3:hadoop27 tester$ ls
LICENSE.txt      README.txt      etc      include      libexec      sbin
ree
NOTICE.txt      bin      hadoop-2.7.0-src  lib      logs      share
SCHMAC-TESTER-3:hadoop27 tester$ █
```

Directory Structure of Hadoop

```
SCHMAC-TESTER-3:hadoop27 tester$ ./tree bin  
bin  
|___container-executor  
|___hadoop  
|___hadoop.cmd  
|___hadoopdata  
|___hdfs  
|___hdfs.cmd  
|___mapred  
|___mapred.cmd  
|___rcc  
|___test-container-executor  
|___yarn  
|___yarn.cmd  
SCHMAC-TESTER-3:hadoop27 tester$ ./tree sbin  
sbin  
|___distribute-exclude.sh  
|___hadoop-daemon.sh  
|___hadoop-daemons.sh  
|___hdfs-config.cmd  
|___hdfs-config.sh  
|___httpfs.sh  
|___kms.sh  
|___mr-jobhistory-daemon.sh  
|___refresh-namenodes.sh  
|___slaves.sh  
|___start-all.cmd  
|___start-all.sh  
|___start-balancer.sh  
|___start-dfs.cmd  
|___start-dfs.sh  
|___start-secure-dns.sh  
|___start-yarn.cmd  
|___start-yarn.sh  
|___stop-all.cmd  
|___stop-all.sh  
|___stop-balancer.sh  
|___stop-dfs.cmd  
|___stop-dfs.sh  
|___stop-secure-dns.sh  
|___stop-yarn.cmd  
|___stop-yarn.sh  
|___yarn-daemon.sh  
|___yarn-daemons.sh  
SCHMAC-TESTER-3:hadoop27 tester$
```

Directory Structure of Hadoop



SCHMAC-TESTER-3:hadoop27 tester\$./tree etc

etc

```
  |__ hadoop
  |  |__ capacity-scheduler.xml
  |  |__ configuration.xsl
  |  |__ container-executor.cfg
  |  |__ core-site.xml
  |  |__ hadoop-env.cmd
  |  |__ hadoop-env.sh
  |  |__ hadoop-metrics.properties
  |  |__ hadoop-metrics2.properties
  |  |__ hadoop-policy.xml
  |  |__ hdfs-site.xml
  |  |__ httpfs-env.sh
  |  |__ httpfs-log4j.properties
  |  |__ httpfs-signature.secret
  |  |__ httpfs-site.xml
  |  |__ kms-acls.xml
  |  |__ kms-env.sh
  |  |__ kms-log4j.properties
  |  |__ kms-site.xml
  |  |__ log4j.properties
  |  |__ mapred-env.cmd
  |  |__ mapred-env.sh
  |  |__ mapred-queues.xml.template
  |  |__ mapred-site.xml
  |  |__ mapred-site.xml.template
  |  |__ slaves
  |  |__ ssl-client.xml.example
  |  |__ ssl-server.xml.example
  |  |__ yarn-env.cmd
  |  |__ yarn-env.sh
  |  |__ yarn-site.xml
```

chin

SCHMAC-TESTER-3:hadoop27 tester\$

Directory Structure of Hadoop



```
mynenis-MacBook-Pro:hadoop koteshwars$  
Mynenis-MacBook-Pro:hadoop koteshwars$  
Mynenis-MacBook-Pro:hadoop koteshwars$ cat core-site.xml  
<?xml version="1.0" encoding="UTF-8"?>  
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>  
<!--  
 Licensed under the Apache License, Version 2.0 (the "License");  
 you may not use this file except in compliance with the License.  
 You may obtain a copy of the License at  
  
 http://www.apache.org/licenses/LICENSE-2.0  
  
 Unless required by applicable law or agreed to in writing, software  
 distributed under the License is distributed on an "AS IS" BASIS,  
 WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.  
 See the License for the specific language governing permissions and  
 limitations under the License. See accompanying LICENSE file.  
-->  
  
<!-- Put site-specific property overrides in this file. -->  
  
<configuration>  
    <property>  
        <name>fs.default.name</name>  
        <value>hdfs://localhost:9000</value>  
    </property>  
</configuration>  
Mynenis-MacBook-Pro:hadoop koteshwars$  
Mynenis-MacBook-Pro:hadoop koteshwars$  
Mynenis-MacBook-Pro:hadoop koteshwars$  
Mynenis-MacBook-Pro:hadoop koteshwars$ cat hdfs-site.xml  
<?xml version="1.0" encoding="UTF-8"?>  
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>  
<!--  
 Licensed under the Apache License, Version 2.0 (the "License");  
 you may not use this file except in compliance with the License.  
 You may obtain a copy of the License at  
  
 http://www.apache.org/licenses/LICENSE-2.0  
  
 Unless required by applicable law or agreed to in writing, software  
 distributed under the License is distributed on an "AS IS" BASIS,  
 WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.  
 See the License for the specific language governing permissions and  
 limitations under the License. See accompanying LICENSE file.  
-->  
  
<!-- Put site-specific property overrides in this file. -->  
  
<configuration>  
    <property>  
        <name>dfs.replication</name>  
        <value>1</value>  
    </property>  
</configuration>  
Mynenis-MacBook-Pro:hadoop koteshwars$ █
```

Configuration of Hadoop

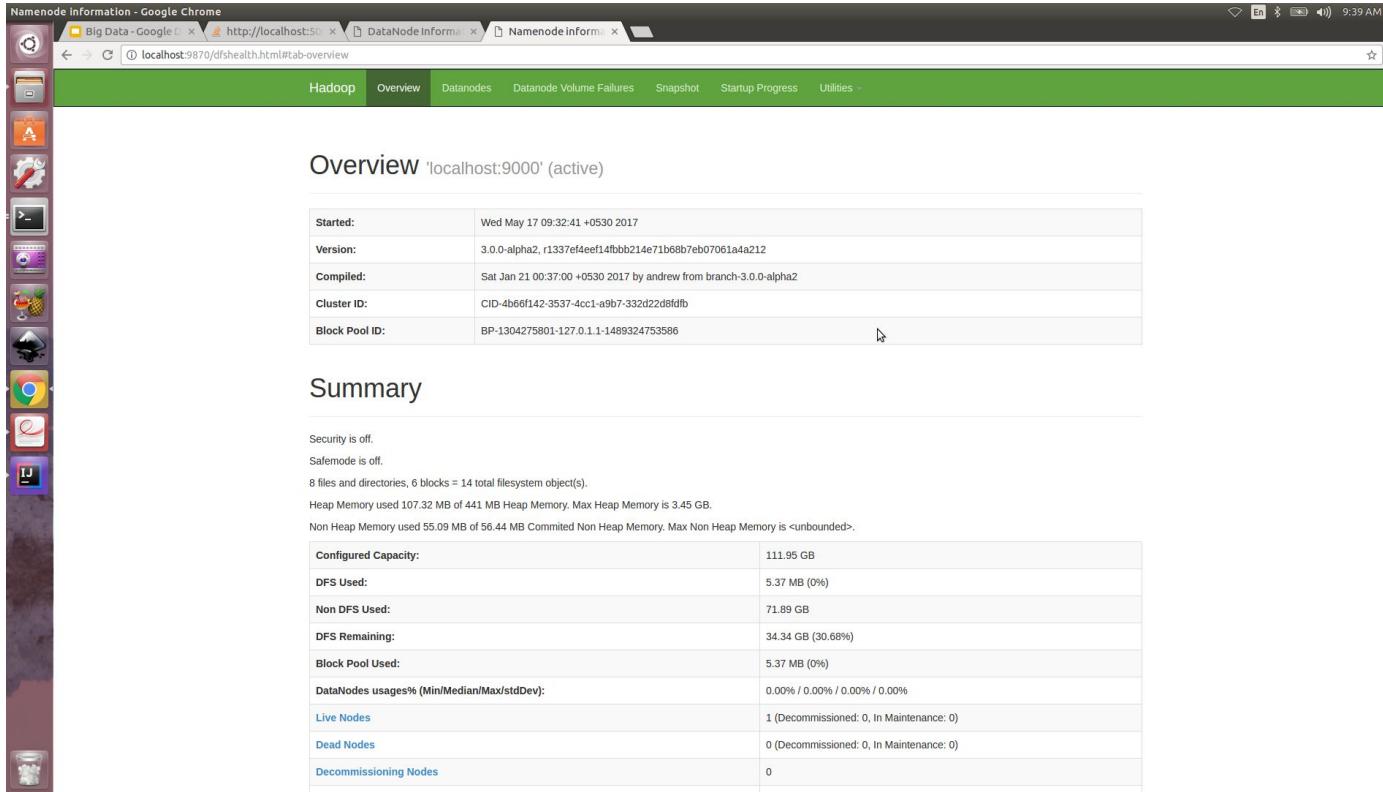
Starting hadoop

`./start-dfs.sh`

`./start-yarn.sh`

Starting hadoop - <http://localhost:9870/>

From Hadoop 3, the port for DFS is on 9870



The screenshot shows a Linux desktop environment with a Unity interface. A Google Chrome window is open, displaying the Hadoop DFS Health Overview page. The URL in the address bar is `http://localhost:9870/dfshealth.html#tab-overview`. The page has a green header with tabs for Hadoop, Overview, Datanodes, Datanode Volume Failures, Snapshot, Startup Progress, and Utilities. The Overview tab is selected. Below the tabs, it says "Overview 'localhost:9000' (active)". The main content area contains a table with cluster information:

Started:	Wed May 17 09:32:41 +0530 2017
Version:	3.0.0-alpha2, r1337ef4ee14fb8b214e71b68b7eb07061a4a212
Compiled:	Sat Jan 21 00:37:00 +0530 2017 by andrew from branch-3.0.0-alpha2
Cluster ID:	CID-4b66f142-3537-4cc1-a9b7-332d22d8fd8b
Block Pool ID:	BP-1304275801-127.0.1.1-1489324753586

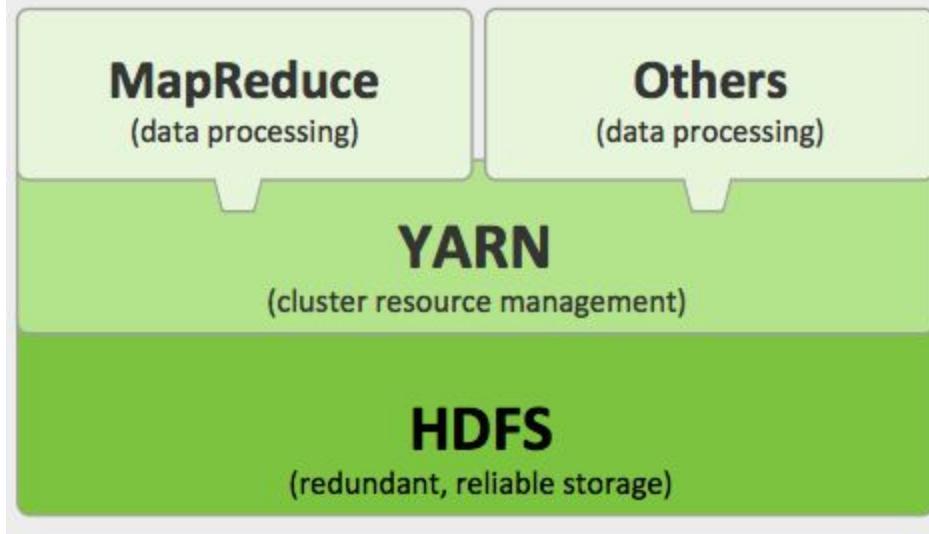
Below this, there is a "Summary" section with the following text:

Security is off.
SafeMode is off.
8 files and directories, 6 blocks = 14 total filesystem object(s).
Heap Memory used 107.32 MB of 441 MB Heap Memory. Max Heap Memory is 3.45 GB.
Non Heap Memory used 55.09 MB of 56.44 MB Committed Non Heap Memory. Max Non Heap Memory is <unbounded>.

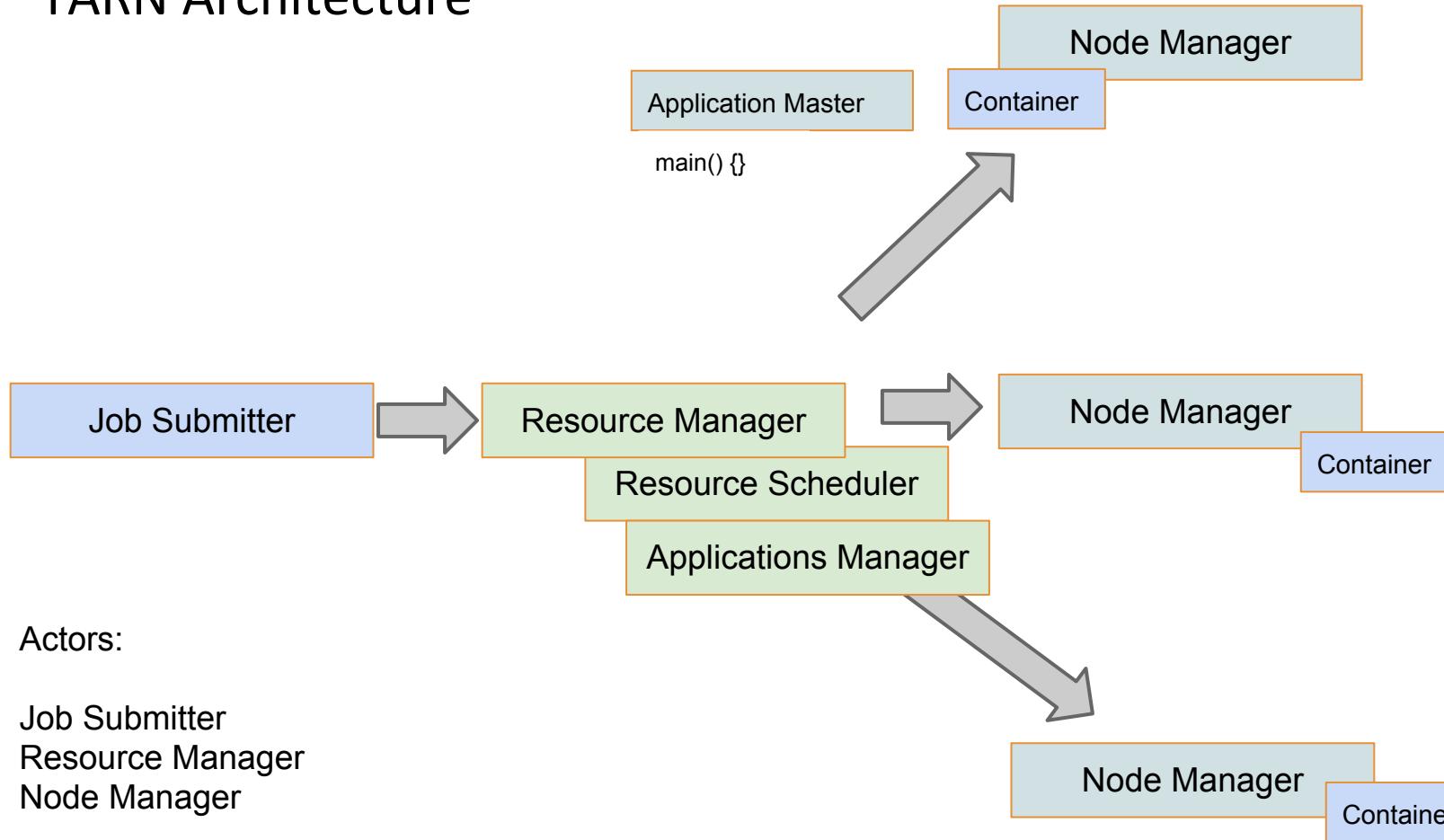
Below the summary text is another table showing disk usage statistics:

Configured Capacity:	111.95 GB
DFS Used:	5.37 MB (0%)
Non DFS Used:	71.89 GB
DFS Remaining:	34.34 GB (30.68%)
Block Pool Used:	5.37 MB (0%)
DataNodes usages% (Min/Median/Max/stdDev):	0.00% / 0.00% / 0.00% / 0.00%
Live Nodes	1 (Decommissioned: 0, In Maintenance: 0)
Dead Nodes	0 (Decommissioned: 0, In Maintenance: 0)
Decommissioning Nodes	0

HADOOP 2.0



YARN Architecture



YARN Architecture

- [1] Client submits an application to the Resource Manager
- [2] Resource manager assigns a container by contacting the Node manager
- [3] The node manager launches the container
- [4] And at last the node manager executes the Application Master

YARN Architecture

```
localhost:hadoop tester$ cat mapred-site.xml
<?xml version="1.0"?>
<!DOCTYPE configuration SYSTEM "http://xml.apache.org/xml-dtds/configuration.dtd">
<!--
    Licensed under the Apache License, Version 2.0 (the "License");
    you may not use this file except in compliance with the License.
    You may obtain a copy of the License at

        http://www.apache.org/licenses/LICENSE-2.0

    Unless required by applicable law or agreed to in writing, software
    distributed under the License is distributed on an "AS IS" BASIS,
    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
    See the License for the specific language governing permissions and
    limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->
<configuration>
    <property>
        <name>mapreduce.framework.name</name>
        <value>yarn</value>
    </property>

    <property>
        <name>mapreduce.jobhistory.address</name>
        <value>localhost:10020</value>
        <description>Host and port for Job History Server (default 0.0.0.0:10020)</description>
    </property>
</configuration>
localhost:hadoop tester$ cat yarn-site.xml
<?xml version="1.0"?>
<!--
    Licensed under the Apache License, Version 2.0 (the "License");
    you may not use this file except in compliance with the License.
    You may obtain a copy of the License at

        http://www.apache.org/licenses/LICENSE-2.0

    Unless required by applicable law or agreed to in writing, software
    distributed under the License is distributed on an "AS IS" BASIS,
    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
    See the License for the specific language governing permissions and
    limitations under the License. See accompanying LICENSE file.
-->
<configuration>
    <property>
        <name>yarn.nodemanager.aux-services</name>
        <value>mapreduce_shuffle</value>
    </property>
</configuration>
localhost:hadoop tester$
```

Speculative Execution

It is an optimization technique adopted by the mapreduce framework.

When a JobTracker finds out that a task takes too much of time to execute, it can start additional instance of the same task.

This process of execution is called **speculative execution**.

Speculative execution ensures that a slowness in a machine will not slow down a task.

Speculative Execution

By default, speculative execution is enabled by default. If you want to disable, give in the below properties in the mapred-site.xml.

```
<property>
<name>mapreduce.map.speculative</name>
<value>false</value>
</property>
```

```
<property>
<name>mapreduce.reduce.speculative</name>
<value>false</value>
</property>
```

Hadoop 3

1. Erasure encoding in HDFS
2. YARN Timeline Service 2.2
3. Support for more than two Namenodes
4. Java 8 is the minimum runtime environment
5. Intra-Datanode Balancer

Erasure coding is a error correcting technique by which the the original data can be constructed using ‘k’ symbols even if ‘m’ symbols are lost. Hadoop 3 uses Reed-Solomon algorithm for erasure coding.



Mapreduce is a method of distributing task across nodes.

In a more elaborate way, mapreduce is a framework for writing in applications that processes tera and peta bytes of data parallelly on many commodity machines.

Mapper

The mapper performs the first task of a mapreduce

Reducer

The reducer performs the second task of a mapreduce

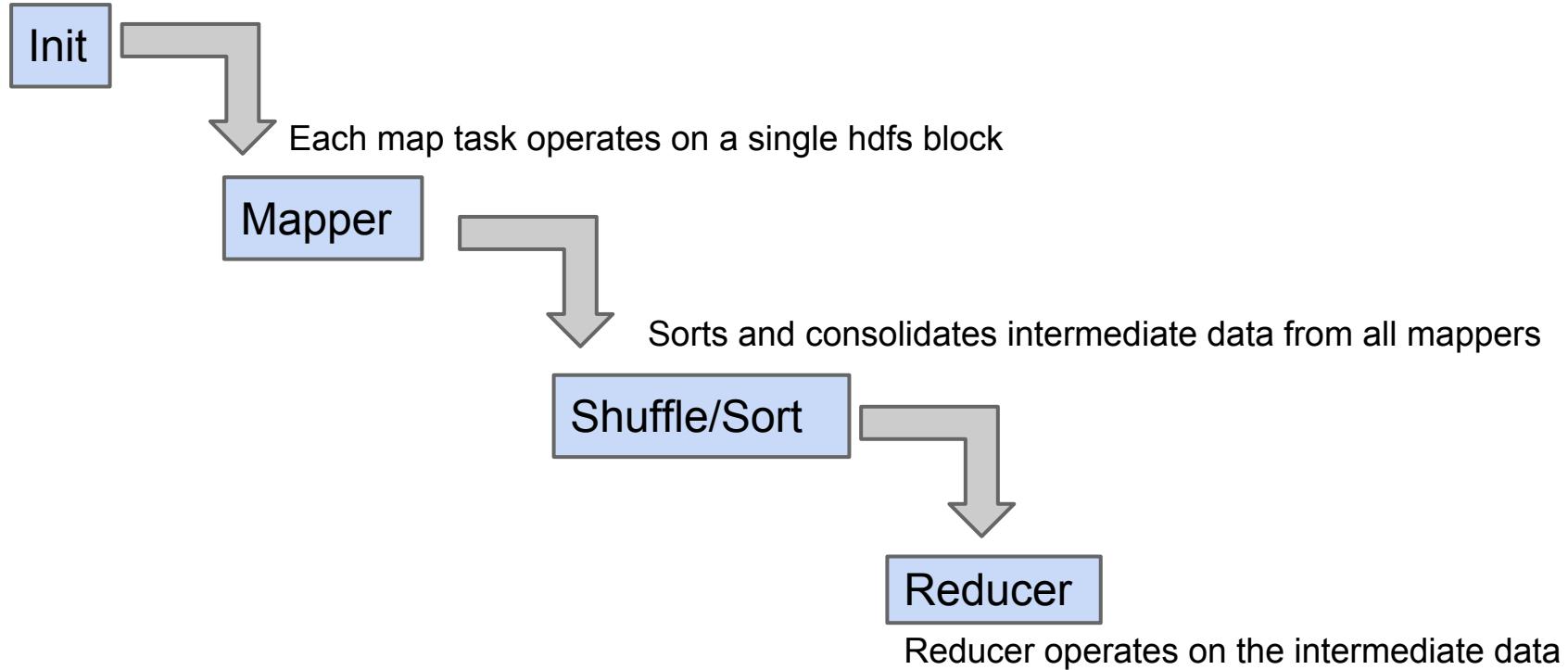
The data is processed to chunks and listed to key-value pairs and then the key-value pairs are given to the reducer

map

It's a higher order function, that applies the given function to each element in the list.

reduce

It's a higher order function, that analyze a recursive data structure, recursively processing its constituent parts building up an output.



init

The input file stored in hdfs is divided into splits. Each split is of a hdfs block. Every split is assigned to a mapper, where the split physically resides.

mapper

Mapper reads the split of the mapper line by line. Mapper computes the application logic and emits key/value pairs.

shuffle and sort

Hadoop partitioner divides the emitted output of the mapper into partitions. Hadoop collects all partitions received from the mappers and sort them by key.

reducer

Hadoop computes the logic in the reduce method and then writes the output to hdfs.

Input

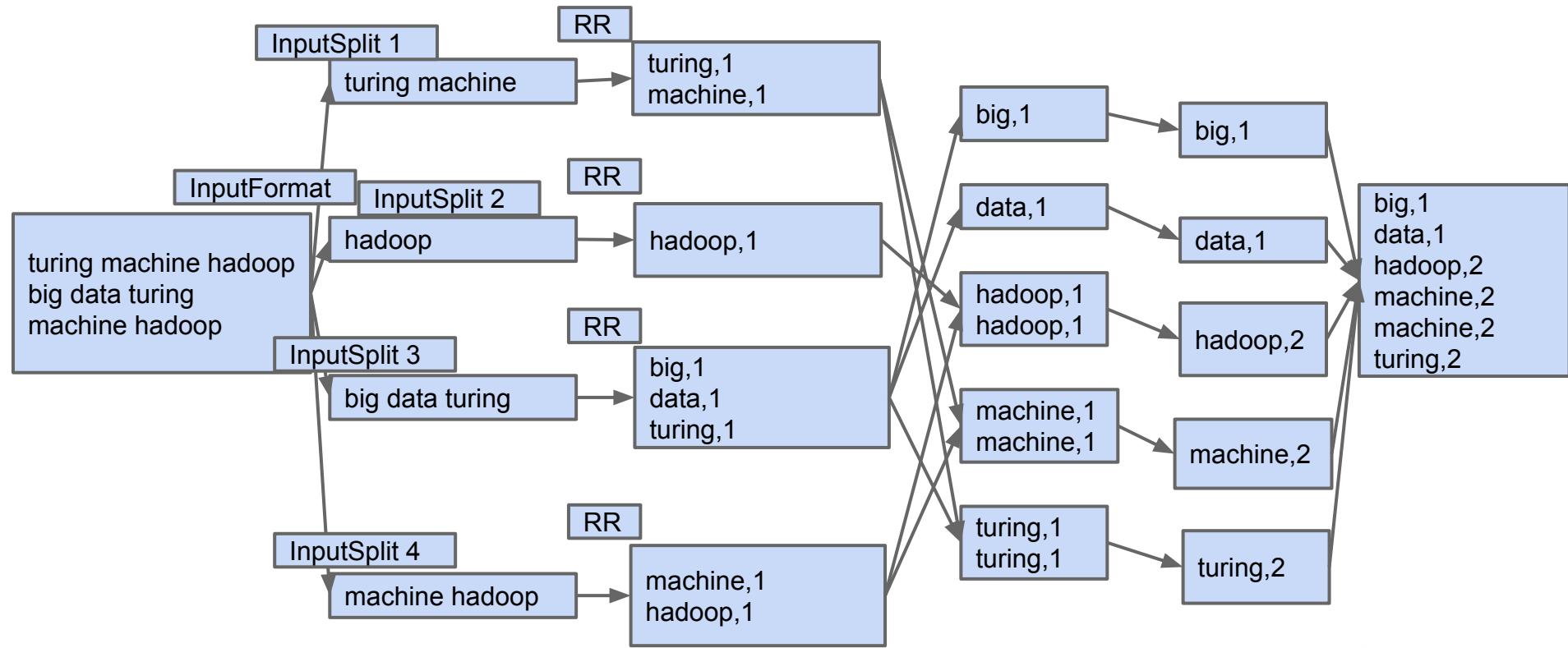
Splitting

Mapping

Shuffling

Reducing

Final Result



Input Files

Data for MapReduce task is stored as Input Files. (typically in hdfs)

InputFormat

The protocol of how the input files are split up and read is defined by the Input Format.

The role of InputFormat is that

- ~ it defines the input splits that break a file into tasks.
- ~ provides a factory for RecordReader.

FileInputFormat reads all files. The default InputFormat is the TextInputFormat. The InputFormat can be set in the setInputFormat() method of the configuration of a Job.

TextInputFormat, KeyValueInputFormat,

SequenceFileInputFormat

InputSplit

An InputSplit defines an unit of work that comprises a single map task. Each map task corresponds to a single input split.

RecordReader

InputSplit has defined a slice of work, but does not describe how to access it. The RecordReader class actually loads the data from its source to (key,value) pairs suitable for reading by the mapper.

Mapper

The map() method ejects out (key,value) parameters which are given as input to the reducers. For every map task, a new instance of mapper class is instantiated in a separate java process.

Partition & Shuffling

The process of moving mapper output to the reducers is called shuffling. In order to help shuffling, an intermediate key space is assigned to each reduce node called by Partition. The partitions are the input to the reducers.

Sort

Each key-value pairs are sorted before producing it to any reducer.

Reducer

The code inside the reduce method is called once for each partition.

OutputFormat

The default is TextOutputFormat. The instances of OutputFormat write files to hdfs.

RecordWriter

The OutputFormat is a factory of RecordWriter objects, that write the individual records to the files as dictated by the OutputFormat.

```

class LineTokenizerMapper extends Mapper<Object, Text, Text, IntWritable> {

    private IntWritable one = new IntWritable(1);
    private Text word = new Text();

    @Override
    protected void map(Object key,
        Text inputLine,
            Mapper<Object, Text, Text, IntWritable>.Context context)
        throws IOException, InterruptedException
    {

        StringTokenizer tokenizedString = new StringTokenizer(inputLine.toString());

        while (tokenizedString.hasMoreTokens()) {
            word.set(tokenizedString.nextToken().trim());
            context.write(word, one);
        }
    }
}

```

```
class CountReducer extends Reducer<Text,IntWritable,Text,IntWritable> {

    private IntWritable result = new IntWritable();

    @Override
    protected void reduce(Text key, Iterable<IntWritable> values,
        Reducer<Text, IntWritable, Text, IntWritable>.Context context)
        throws IOException, InterruptedException {

        int sum = 0;
        for (IntWritable val : values) {
            sum += val.get();
        }
        result.set(sum);

        context.write(key, result);
    }

}
```

```
public static void main(String[] args) throws IOException {  
  
    Configuration conf = new Configuration();  
  
    Job job = Job.getInstance(conf, "WordCount");  
  
    job.setJarByClass(WordCountJob.class);  
  
    job.setMapperClass(LineTokenizerMapper.class);  
  
    job.setReducerClass(CountReducer.class);  
  
    job.setOutputKeyClass(Text.class);  
  
    job.setOutputValueClass(IntWritable.class);  
  
}  
}
```

Job Tracker & Task Tracker

Job Tracker is the master of the system which manages the jobs and resources of the cluster.

Task Tracker are the slaves deployed on each of the machines. They are responsible for running i



What is pig ?

Pig is a program used for transformation, operation and exploration on large datasets of data.

Pig Latin is the data flow language used to write pig scripts.

Pig power comes from the fact that it can analyze terabytes of code by issuing few lines of code rather than writing complex-boiler plate map-reduce programs.

Developed by Yahoo and now a Apache guy.

grunt

```
localhost:input tester$  
localhost:input tester$ pig  
15/08/10 13:47:25 INFO pig.ExecTypeProvider: Trying ExecType : LOCAL  
15/08/10 13:47:25 INFO pig.ExecTypeProvider: Trying ExecType : MAPREDUCE  
15/08/10 13:47:25 INFO pig.ExecTypeProvider: Picked MAPREDUCE as the ExecType  
2015-08-10 13:47:25,059 [main] INFO org.apache.pig.Main - Apache Pig version 0.15.0 (r1682971) compiled Jun 01 2015, 11:44:35  
2015-08-10 13:47:25,059 [main] INFO org.apache.pig.Main - Logging error messages to: /Users/tester/examples/sshd/input/pig_1439194645058.log  
2015-08-10 13:47:25,074 [main] INFO org.apache.pig.impl.util.Utils - Default bootup file /Users/tester/.pigbootup not found  
2015-08-10 13:47:25,467 [main] INFO org.apache.hadoop.conf.Configuration.deprecation - mapred.job.tracker is deprecated. Instead, use mapreduce.jobtracker.address  
2015-08-10 13:47:25,467 [main] INFO org.apache.hadoop.conf.Configuration.deprecation - fs.default.name is deprecated. Instead, use fs.defaultFS  
2015-08-10 13:47:25,467 [main] INFO org.apache.pig.backend.hadoop.executionengine.HExecutionEngine - Connecting to hadoop file system at: hdfs://localhost:9000  
2015-08-10 13:47:25,622 java[65450:1903] Unable to load realm info from SCDynamicStore  
2015-08-10 13:47:25,634 [main] WARN org.apache.hadoop.util.NativeCodeLoader - Unable to load native-hadoop library for your platform... using builtin-  
java classes where applicable  
2015-08-10 13:47:26,018 [main] INFO org.apache.hadoop.conf.Configuration.deprecation - fs.default.name is deprecated. Instead, use fs.defaultFS  
grunt>  
grunt>  
grunt>
```

command line

Runs in the local mode

```
$ pig -x local
```

Runs in the cluster

```
$ pig or $ pig -x mapreduce
```

Running Pig Script as a command line:

```
$ pig -param input=/data/sshd.log pigscript.pig  
pigscript.pig
```

```
sshdLog = LOAD '$input' USING PigStorage AS line:chararray;  
  
sshd_schema = FOREACH sshdLog GENERATE FLATTEN(REGEX_EXTRACT_ALL(line,  
'(.\\s\\d{2}\\s\\d{2}:\\d{2}:\\s.*(Accepted.*password.*|\\sfo.*\\s(\\S.*|\\sfr.*\\s(.*)\\spo.*)) as (timestamp:chararray, eventtype:chararray, userid:chararray,  
ipaddr:chararray);  
complete_sshd_schema = FILTER sshd_schema BY timestamp != '';  
grouped_complete_sshd_schema = GROUP complete_sshd_schema BY timestamp;  
STORE grouped_complete_sshd_schema INTO '/data/output_two' USING PigStorage('');
```

Quit from grunt

```
grunt> quit
```

Load and Store Functions

```
grunt> titanic_data = LOAD '/data/titanic.csv' USING  
    PigStorage(',')
```

AS

```
(Passengerid:int,Survived:int,Pclass:int,LName:chararray,  
FName:chararray,Sex:chararray,Age:int,SibSp:int,Parch:int,  
Ticket:chararray,Fare:double,Cabin:chararray,Embarked  
:chararray);
```

```
grunt> STORE titanic_data INTO '/data/titanic_data_store'  
    USING PigStorage(':'');
```

```
grunt> cat /data/titanic_data_store
```

Load and Store Functions

- PigStorage : Loads and stores data using field delimiter. It is the default storage.
- BinStorage : Loads and stores data from binary files.
- TextLoader : Loads data from text format.
- JsonLoader, JsonStorage : Loads and stores data from a JSON.
- HBaseStorage : Loads and stores data from HBASE

grunt supports hadoop filesystem commands

ls

cat

cd

mkdir

rm

```
grunt> ls /data
hdfs://localhost:9000/data/group_four    <dir>
hdfs://localhost:9000/data/group_three   <dir>
hdfs://localhost:9000/data/grouped_complete_sshd_schema <dir>
hdfs://localhost:9000/data/output_one_grouped_complete_sshd_schema      <dir>
hdfs://localhost:9000/data/output_two     <dir>
hdfs://localhost:9000/data/sshd<r 1>    34409657
hdfs://localhost:9000/data/sshd.log<r 1>  34409657
hdfs://localhost:9000/data/sshd_store    <dir>
hdfs://localhost:9000/data/sshd_store_pam_unix <dir>
hdfs://localhost:9000/data/titanic.csv<r 1>  61194
hdfs://localhost:9000/data/titanic_data_store <dir>
grunt>
grunt>
grunt> cat /data/group_four
Nov 01 21:07:02:{(Nov 01 21:07:02,Accepted password,krr,122.172.254.242)}
Nov 02 06:48:39:{(Nov 02 06:48:39,Accepted password,krr,122.172.254.242)}
Nov 02 12:15:04:{(Nov 02 12:15:04,Accepted password,krr,122.172.254.242)}
Nov 02 12:42:52:{(Nov 02 12:42:52,Accepted password,krr,122.172.254.242)}
Nov 04 12:10:09:{(Nov 04 12:10:09,Accepted password,krr,122.172.254.242)}
grunt> cd /data
grunt> ls
hdfs://localhost:9000/data/group_four    <dir>
hdfs://localhost:9000/data/group_three   <dir>
hdfs://localhost:9000/data/grouped_complete_sshd_schema <dir>
hdfs://localhost:9000/data/output_one_grouped_complete_sshd_schema      <dir>
hdfs://localhost:9000/data/output_two     <dir>
hdfs://localhost:9000/data/sshd<r 1>    34409657
hdfs://localhost:9000/data/sshd.log<r 1>  34409657
hdfs://localhost:9000/data/sshd_store    <dir>
hdfs://localhost:9000/data/sshd_store_pam_unix <dir>
hdfs://localhost:9000/data/titanic.csv<r 1>  61194
hdfs://localhost:9000/data/titanic_data_store <dir>
grunt>
```



Load and Store Functions

If you are running in a local mode, you can give in a file too

```
grunt> sshdLog = LOAD
```

```
'file:/Users/tester/examples/sshd/input/sshd.log'
```

```
USING PigStorage AS line:chararray;
```

DUMP and DESCRIBE

The contents of the alias or relations are examined using the dump function and the describe operator gives the structure of the relation.

```
grunt>
```

```
titanic_data = LOAD '/data/titanic.csv'  
USING PigStorage(',')  
AS  
(Passengerid:int,Survived:int,Pclass:int,LName:chararray,FName:chararray,Sex:chararray,Age:int,SibSp:int,Parch:int,Ticket:chararray  
,Fare:double,Cabin:chararray,Embarked:chararray);
```

```
grunt> dump titanic_data;
```

DUMP and DESCRIBE

```
grunt>
```

```
titanic_data = LOAD '/data/titanic.csv'  
USING PigStorage(',')  
AS  
(Passengerid:int,Survived:int,Pclass:int,LName:chararray,FName:chararray,Sex:chararray,Age:int,SibSp:int,Parch:int,Ticket:chararray  
,Fare:double,Cabin:chararray,Embarked:chararray);
```

```
grunt> describe titanic_data;
```

```
titanic_data: {Passengerid: int,Survived: int,Pclass: int,LName: chararray,FName: chararray,Sex: chararray,Age: int,SibSp: int,Parch:  
int,Ticket: chararray,Fare: double,Cabin: chararray,Embarked: chararray}
```

Pig Data Types

Numeric int, long, float, double

Text chararray

Binary bytearray

Complex tuple, bag, map

Illustrate and Explain

Explain gives in the logical and physical plan

```
grunt> explain grouped_complete_sshd_schema;
```

Illustrate gives in the sample execution of the logical plan with a sample output

```
grunt> illustrate grouped_limited_schema;
```

Explain

```
# Map Reduce Plan
#-----
MapReduce node scope-600
Map Plan
grouped_complete_sshd_schema: Local Rearrange[tuple]{chararray}{false} - scope-597
| |
| Project[chararray][0] - scope-598
|---complete_sshd_schema: Filter[bag] - scope-591
| |
| Not Equal To[boolean] - scope-594
|---Project[chararray][0] - scope-592
|---Constant() - scope-593
|---sshd_schema: New For Each(true)[bag] - scope-590
| |
| POUUserFunc(org.apache.pig.builtin.REGEX_EXTRACT_ALL)[tuple] - scope-588
| |
|---Cast[chararray] - scope-586
| |
|---Project[bytearray][0] - scope-585
|---Constant((.*\s\d{2}\s\d{2}:\d{2}:\d{2})\s*(Accepted.*password.*)\sfo.*\s(\S.*)\sfr.*\s(.*)\spo.*) - scope-587
|---sshdLog: Load(/data/sshd.log:PigStorage) - scope-584-----
Reduce Plan
grouped_complete_sshd_schema: Store(fakefile:org.apache.pig.builtin.PigStorage) - scope-599
|
|---grouped_complete_sshd_schema: Package(Packager)[tuple]{chararray} - scope-596-----
Global sort: false
-----
```

Illustrate

```
| sshdLog    | line:chararray
|           |
| Nov 01 21:07:02 localhost.localdomain sshd[21558]: Accepted password for krr from 122.172.254.242 port 61776 ssh2
| Nov 01 21:07:02 localhost.localdomain sshd[21558]: Accepted password for krr from 122.172.254.242 port 61776 ssh2
| Nov 01 06:15:17 localhost.localdomain sshd[13193]: PAM service(sshd) ignoring max retries; 6 > 3
| Nov 01 08:47:17 localhost.localdomain sshd[13763]: Failed password for root from 122.225.97.87 port 50169 ssh2
| Nov 01 11:44:11 localhost.localdomain sshd[15484]: error: Could not load host key: /etc/ssh/ssh_host_dsa_key
| Nov 02 01:39:19 localhost.localdomain sshd[27634]: Failed password for invalid user admin from 122.225.109.115 port 40829 ssh2
| Nov 01 21:07:02 localhost.localdomain sshd[21558]: Accepted password for krr from 122.172.254.242 port 61776 ssh2
| Nov 01 21:07:02 localhost.localdomain sshd[21558]: Accepted password for krr from 122.172.254.242 port 61776 ssh2
| Nov 02 01:39:19 localhost.localdomain sshd[27634]: Failed password for invalid user admin from 122.225.109.115 port 40829 ssh2
| Nov 01 06:15:17 localhost.localdomain sshd[13193]: PAM service(sshd) ignoring max retries; 6 > 3
| Nov 01 11:44:11 localhost.localdomain sshd[15484]: error: Could not load host key: /etc/ssh/ssh_host_dsa_key
| Nov 01 08:47:17 localhost.localdomain sshd[13763]: Failed password for root from 122.225.97.87 port 50169 ssh2
| complete_sshd_schema | timestamp:chararray      | eventtype:chararray   | userid:chararray     | ipaddr:chararray
|           |
| Nov 01 21:07:02   | Accepted password | krr                | 122.172.254.242
| Nov 01 21:07:02   | Accepted password | krr                | 122.172.254.242
| Nov 01 21:07:02   | Accepted password | krr                | 122.172.254.242
| Nov 01 21:07:02   | Accepted password | krr                | 122.172.254.242
| grouped_complete_sshd_schema | group:chararray | complete_sshd_schema:bag{:tuple(timestamp:chararray,eventtype:chararray,userid:chararray,ipaddr:chararray)}
|           |
| Nov 01 21:07:02 | {(Nov 01 21:07:02, ..., 122.172.254.242), ..., (Nov 01 21:07:02, ..., 122.172.254.242)}
```

FILTER, GROUP and LIMIT

```
sshdLog = LOAD '/data/sshd.log' USING PigStorage AS line:chararray;
```

```
sshd_schema = FOREACH sshdLog GENERATE FLATTEN(REGEX_EXTRACT_ALL(line,  
'(.*\s\d{2}\s\d{2}:\d{2}:\d{2})\s.*(Accepted.*password.*)\sfo.*\s(\S.*\sfr.*\s(.*)\spo.*)')  
as  
(timestamp:chararray, eventtype:chararray, userid:chararray, ipaddr:chararray);
```

```
complete_sshd_schema = FILTER sshd_schema BY timestamp != ";
```

```
grouped_complete_sshd_schema = GROUP complete_sshd_schema BY timestamp;
```

```
grouped_limited_schemea = LIMIT grouped_complete_sshd_schema 5;
```

train1000.csv

8,2011-06-11,20.11

8,2011-06-13,1.19

8,2011-06-14,15.80

8,2011-06-15,7.09

8,2011-06-16,32.51

8,2011-06-17,16.67

8,2011-06-19,31.37

11,2010-04-04,13.88

11,2010-04-05,72.78

11,2010-04-10,115.87

11,2010-04-12,10.06

11,2010-04-22,1.83

11,2010-05-01,38.95

11,2010-05-05,12.50

11,2010-05-07,13.23

11,2010-05-18,36.18

TOBAG and TOTUPLE

```
rfm_data = LOAD '/data/train1000.csv' USING PigStorage(',') AS (custid:int, date:chararray, amount:float);  
  
custid_and_amount_bag = FOREACH rfm_data GENERATE TOBAG(custid, amount);  
  
custid_time_amount_tuple = FOREACH rfm_data GENERATE TOTUPLE(custid, date, amount);
```

<i>BAG</i>	<i>TUPLE</i>
((8),(3.28))	((8,2011-06-14,15.8))
((8),(20.11))	((8,2011-06-15,7.09))
((8),(1.19))	((8,2011-06-16,32.51))
((8),(31.37))	((8,2011-06-17,16.67))
((11),(13.88))	((8,2011-06-19,31.37))
((11),(72.78))	((11,2010-04-04,13.88))
((11),(115.87))	((11,2010-04-05,72.78))
	((11,2010-04-10,115.87))
	((11,2010-04-12,10.06))
	((11,2010-04-22,1.83))
	((11,2010-05-01,38.95))

Load using \$0, \$1, \$2....

```
rfm_data = LOAD '/data/train1000.csv' USING PigStorage(',');
```

```
cust_id_and_amount = FOREACH rfm_data
```

```
    GENERATE $0 AS custid:int,  
           $1 AS date,  
           $2 AS amount;
```

```
grunt> describe cust_id_and_amount;
```

```
cust_id_and_amount: {custid: int,date: bytearray,amount: bytearray}
```

SUM

```
rfm_data = LOAD '/data/train1000.csv' USING PigStorage(',') AS (custid:int, date:chararray, amount:float)
cust_id_amount = FOREACH rfm_data generate custid, amount;
custid_group = GROUP cust_id_amount BY custid;

monitory = FOREACH custid_group GENERATE group, SUM(cust_id_amount.amount);
```

UDF - Pig User Defined Functions

```
package com.dmac.pig;
```

```
import java.io.IOException;
```

```
import org.apache.pig.EvalFunc;
```

```
import org.apache.pig.data.Tuple;
```

```
import org.apache.pig.data.TupleFactory;
```

```
public class CustomerIDToNameMapperUDF extends EvalFunc<Tuple> {
```

```
    @Override
```

```
    public Tuple exec(Tuple input) throws IOException {
```

```
        String customerName      = "";
        String typeOfCustomer   = "";
        String timeStamp         =     "";
```

```
        Integer id = (Integer)input.get(0);
        timeStamp = (String)input.get(1);
        Float amount = (Float)input.get(2);
```

```
        if (amount > 100)
```

```
            typeOfCustomer = "HIGH-END-CUSTOMER";
```

```
        else
```

```
            typeOfCustomer = "LOW-END-CUSTOMER";
```

```
        if (id.intValue() == 11)
```

```
            customerName = "Aravindh";
```

```
        else if (id.intValue() == 8)
```

```
            customerName = "Alan";
```

```
        else
```

```
            customerName = "Turing";
```

```
        Tuple output = TupleFactory.getInstance().newTuple(3);
```

```
        output.set(0, customerName);
```

```
        output.set(1, timeStamp);
```

```
        output.set(2, typeOfCustomer);
```

```
        return output;
```

UDF

```
$ javac -classpath
```

```
/home/bdsa/hadoop/pig-0.15.0/pig-0.15.0-core-h1.jar:/home/bdsa/hadoop-common-2  
.3.0.jar CustomerIDToNameMapperUDF.java
```

```
$ jar cvf usemyudf.jar com/
```

```
grunt> REGISTER usemyudf.jar
```

```
grunt> rfm_data = LOAD '/data/dunhumby/input/train1000.csv' USING  
PigStorage(',') AS (custid:int, date:chararray, amount:float);
```

```
grunt> formatted_data = FOREACH rfm_data generate  
com.dmac.pig.CustomerIDToNameMapperUDF(custid, date, amount);  
grunt> dump formatted_data;
```



Parallelism

```
GROUP complete_sshd_schema BY timestamp PARALLEL 40;
```

```
set default_parallel 30
```



Apache Hive

Apache Hive is a warehouse infrastructure tool to analyze structured data.

A platform where we write in SQL scripts to do map-reduce applications.

The Hive Query Language (HQL) is used to write in queries for hive.



Install Hive

[1] Download derby. Hive metastore needs a database.

https://db.apache.org/derby/derby_downloads.html

[2] Edit .bashrc in the home folder to have the derby bin path included in the .bashrc file.
export PATH="/home/dharshekthvel/anaconda2/bin:/home/dharshekthvel/ac/bin/db-derby-10.13.1.1-bin/bin:\$PATH"

[3] Rename *hive-default.xml.template* to *hive-site.xml* which is in the *hive/conf*



Install Hive

[4] Edit the `hive-site.xml` to have this property

```
<property>
  <name>javax.jdo.option.ConnectionURL</name>
  <value>jdbc:derby://localhost:1527/metastore_db;create=true</value>
  <description>
    JDBC connect string for a JDBC metastore.
    To use SSL to encrypt/authenticate the connection, provide database-specific SSL flag in the connection URL.
    For example, jdbc:postgresql://myhost/db?ssl=true for postgres database.
  </description>
</property>
```

[5] Copy the jar files to the lib directory of the hive. Copy `derbyclient.jar` and `derbytools.jar` file to the lib folder of the hive.

[6] Start the Derby database. `/ac/bin/db-derby-10.13.1.1-bin/bin$./startNetworkServer`

[7] `hive/bin./schematool -dbType derby -initSchema`

Hive Shell Commands

```
hive> create schema bigdatadb;          (or)
hive> create database analyticsdb;
```

```
hive> CREATE TABLE IF NOT EXISTS SRILANKA(id int, name String);
hive> CREATE TABLE IF NOT EXISTS DHARSHEKTH(name String) STORED AS TEXTFILE;
```

```
hive> show databases;
hive> show tables;
```

Hive Tables

Internal

On dropping the internal tables, the data inside them is also lost forever.

```
CREATE TABLE RAMS_TRIP ( trip INT, date STRING)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
LOCATION '/hive/data/rams';
```

External - On dropping the external table, the data inside them is not deleted.

The data would be still present in the HDFS.

```
CREATE EXTERNAL TABLE RAMS_TRIP ( trip INT, date STRING)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
LOCATION '/hive/data/rams';
```



Hive UDF

UDF User Defined Functions

UDAF User Defined Aggregate Functions

UDTF User Defined Table Functions

Hive UDF

UDF User Defined Functions

```
import org.apache.hadoop.hive.ql.  
exec.UDF;  
  
import org.apache.hadoop.hive.ql.exec.UDFArgumentException;  
import org.apache.hadoop.hive.ql.metadata.HiveException;  
import org.apache.hadoop.hive.ql.udf.generic.GenericUDF;  
import org.apache.hadoop.hive.serde2.objectinspector.ObjectInspector;  
  
public class StockValuePer extends GenericUDF {  
  
    @Override  
    public Object evaluate(DeferredObject[] arg0) throws HiveException {  
        // TODO Auto-generated method stub  
        return null;  
    }  
  
    @Override  
    public String getDisplayString(String[] arg0) {
```



Hive UDTF

UDTF User Defined Table Functions

```
import org.apache.hadoop.hive.ql.exec.UDFArgumentException;
import org.apache.hadoop.hive.ql.metadata.HiveException;
import org.apache.hadoop.hive.ql.udf.generic.GenericUDTF;
import org.apache.hadoop.hive.serde2.objectinspector.ObjectInspector;
import org.apache.hadoop.hive.serde2.objectinspector.StructObjectInspector;
```

```
public class StockPercentageCalculator extends GenericUDTF{
```

```
    @Override
```

```
    public void close() throws HiveException {
        // TODO Auto-generated method stub
```

Hive UDAF

UDAF for hive is the User Defined Aggregate Function which is used to write in aggregations.



Hive MapJoin

MapJoin allows a table to be loaded into the memory, so by which a join is performed only with mappers, without having to use Map/Reduce step.

If the queries frequently rely on small table joins then we could use a MapJoin.

```
select /*+ MAPJOIN(dept) */ emp.name, dept.dept from employee emp JOIN department dept ON (emp.empid=dept.empid);
```

Hive Metastore

The Hive metastore stores the metadata of hive tables.

Used in capturing analytics of big data.

Usually configured to an external database. Typically MYSQL.



Hive Metastore - Tables in metastore

```
mysql> use metastore  
Reading table information for completion of table and column names  
You can turn off this feature to get a quicker startup with -A
```

metastore is the schema used
by hive

```
Database changed  
mysql> show tables;  
+-----+  
| Tables_in_metastore |  
+-----+  
| BUCKETING_COLS      |  
| CDS                 |  
| COLUMNS_V2          |  
| COMPACTION_QUEUE    |  
| COMPLETED_TXN_COMPONENTS |  
| DATABASE_PARAMS     |  
| DBS                 |  
| DB_PRIVS            |  
| DELEGATION_TOKENS   |  
| FUNCS               |  
| FUNC_RU             |  
| GLOBAL_PRIVS        |
```



Hive Metastore - Tables in metastore

HIVE_LOCKS		SD_PARAMS	
IDXS		SEQUENCE_TABLE	
INDEX_PARAMS		SERDES	
MASTER_KEYS		SERDE_PARAMS	
NEXT_COMPACTION_QUEUE_ID		SKEWED_COL_NAMES	
NEXT_LOCK_ID		SKEWED_COL_VALUE_LOC_MAP	
NEXT_TXN_ID		SKEWED_STRING_LIST	
NUCLEUS_TABLES		SKEWED_STRING_LIST_VALUES	
PARTITIONS		SKEWED_VALUES	
PARTITION_EVENTS		SORT_COLS	
PARTITION_KEYS		TABLE_PARAMS	
PARTITION_KEY_VALS		TAB_COL_STATS	
PARTITION_PARAMS		TBLS	
PART_COL_PRIVS		TBL_COL_PRIVS	
PART_COL_STATS		TBL_PRIVS	
PART_PRIVS		TXNS	
ROLES		TXN_COMPONENTS	
ROLE_MAP		TYPES	
SDS		TYPE_FIELDS	
		VERSION	
		+-----+	

Impala



Impala

Impala is a massive SQL query engine for processing huge volumes of data.

Written in C++ and Java.

Not runs MR-JOB, but runs impala-daemon process.

Impala

Impala is a product from Cloudera which acts a SQL on top of HDFS.

Impala

Main components

Impala daemon

Impala StateStore

Impala Metastore

Query processing Interfaces

Impala-shell

Hue Interface

ODBC/JDBC Driver

Impala

Impala daemon

Impala daemon runs on each and every system.

Impala StateStore

The StateStore is responsible for checking the health of each daemon.

Impala Metastore

Impala uses mysql or postgresql for storing the metadata.

APACHE
HBASE

Apache HBase

Apache HBase is a columnar storage for the hadoop by Mike Cafarella.

hbase shell

```
#list the tables
list

# Create a table
create 'hbase_data_table', 'personal_data', 'professional_data'

# Describing the table
describe 'hbase_data_table'

# Inserting Data
put 'hbase_data_table','1','personal_data:fathers_name','chinnasamy'
put 'hbase_data_table','1','professional_data:experience','2'

# Retrieving Data
scan 'hbase_data_table'
```

hbase - create table

```
HTableDescriptor ht = new HTableDescriptor("PEOPLES");

ht.addFamily( new HColumnDescriptor("professional_data"));

ht.addFamily( new HColumnDescriptor("personal_data"));

HBaseAdmin hba = new HBaseAdmin( conf );

hba.createTable(ht);
```

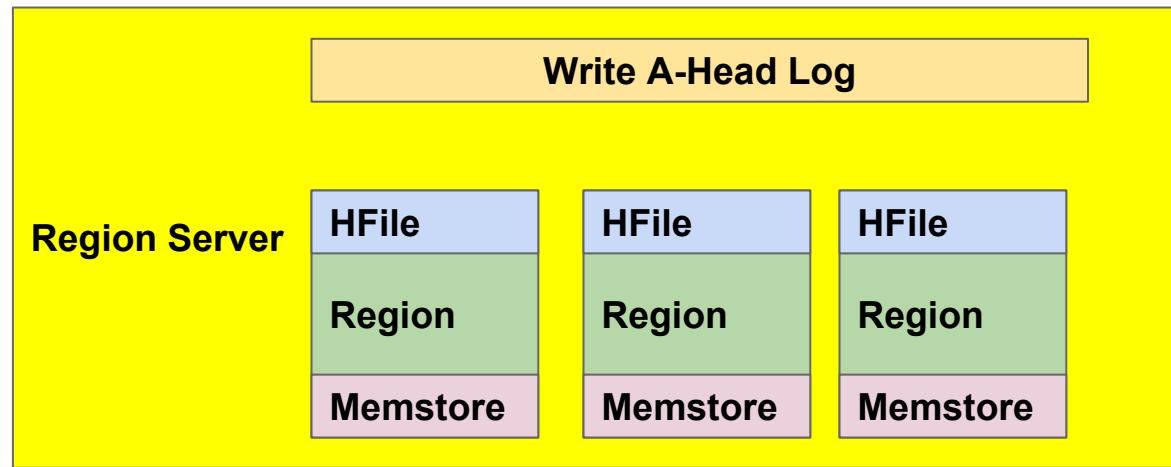
hbase - insert data

```
HTable htable = new HTable(conf, "PEOPLES");

Put put = new Put(Bytes.toBytes("rowKey-11002233"));
put.add(Bytes.toBytes("professional_data"), Bytes.toBytes("experience"), Bytes.toBytes("2"));
put.add(Bytes.toBytes("professional_data"), Bytes.toBytes("technology"), Bytes.toBytes("JAVA"));

htable.put(put);
```

HBASE Architecture



hbase architecture

HBase is the counterpart of the google's Big Table. The following are the various components in HBase.

Client Program

Master Server

Region Server

Regions

Store

Memstore

HFile

WAL

Each component's functionality is described below.

Master Server: Coordinates with zookeeper. Master use the zookeeper zNodes to check on the availability of the zookeeper nodes. Also zookeeper is used for checking on the network failures on the nodes.

Region Servers: The regions are stored in the region servers. Handles all read and write and data updates. The Region server contains store and regions.

hbase architecture

Store: The store contains Memstore and HFile.

Memstore is a cache. HBase stores data in memstore first and then flushes data to HFile as blocks which are stored in the file system.

WAL (Write A-Head Log): WAL stores the set of writes and when a server crashes it writes.

Regions: The tables are split and stored in regions. Each region is assigned to a region server.

Regions contain in-memory data store (Memstore) and a persistent data store (HFile) and all regions share a reference to WAL(Write AHead Log).

hbase shell

```
=> ["PEOPLES", "Table_name", "countries", "hbase_data_table"]
hbase(main):007:0> scan 'PEOPLES'
ROW                                         COLUMN+CELL
  rowKey-11002233                          column=professional_data:experience, timestamp=1441810670218, value=2
  rowKey-11002233                          column=professional_data:technology, timestamp=1441810670218, value=JAVA
1 row(s) in 0.1890 seconds

hbase(main):008:0> █
```

hbase shell

```
hbase(main):001:0> list 'TABLE_NAME'
```

```
hbase (main):001:0> list '/template'  
TABLE  
/template/kycresponseaudit  
/template/genericotpaudittrail  
/template/dbaudittrail  
/template/updateaudittrail  
/template/authdataextractiontracker  
/template/authaudittrail  
/template/sample_emp  
/template/bfdaudittrail  
/template/residentdetail  
/template/authauditindex  
/template/authauditindexgndc  
/template/authaudittracker  
/template/otpauditindex  
/template/residentbiometricdata  
/template/authaudittrailgndc  
/template/otpaudittrail  
/template/residentdetail_nonprod  
/template/test  
/template/genericotpauditindex  
/template/mouresponseaudit  
/template/bfdauditindex  
21 row(s) in 0.3930 seconds  
  
hbase (main):002:0>
```

hbase shell - Filters

```
hbase(main):001:0> show_filters
```

```
hbase(main):004:0> show filters
Documentation on filters mentioned b
ColumnPrefixFilter
TimestampsFilter
PageFilter
MultipleColumnPrefixFilter
FamilyFilter
ColumnPaginationFilter
SingleColumnValueFilter
RowFilter
QualifierFilter
ColumnRangeFilter
ValueFilter
PrefixFilter
SingleColumnValueExcludeFilter
ColumnCountGetFilter
InclusiveStopFilter
DependentColumnFilter
FirstKeyOnlyFilter
KeyOnlyFilter

hbase(main):005:0>
```



Apache Sqoop

Sqoop is a command line tool used to transfer data from relational database to hadoop.

Import Command

```
$ sqoop  
import  
--connect jdbc:mysql://localhost/nav --username root --password  
cloudera --table movies  
--m 1  
--target-dir /movie1
```

Apache Flume

Apache Flume - Config

```
# Naming the components on the current agent.
```

```
TwitterAgent.sources = Twitter
```

```
TwitterAgent.channels = MemChannel
```

```
TwitterAgent.sinks = HDFS
```

```
# Describing/Configuring the source
```

```
TwitterAgent.sources.Twitter.type = org.apache.flume.source.twitter.TwitterSource
```

```
TwitterAgent.sources.Twitter.consumerKey = H7gCcVkw7HI8C4hbgEo62h6zF
```

```
TwitterAgent.sources.Twitter.consumerSecret = yGgJ8iT5FKoNcrMWCE31tmQqtKzPiSnhiX9XuXIFP4P54XVdxg
```

```
TwitterAgent.sources.Twitter.accessToken = 837928192170209280-v0p7XGPdehsV0VSTouN6YisQReaEQGt
```

```
TwitterAgent.sources.Twitter.accessTokenSecret = 6HnqRgWUyQWPSUfKKpthSP7jXUBFfU7hVop6vlfJxUQpL
```

```
TwitterAgent.sources.Twitter.keywords = jallikattu, neduvusal
```

```
# Describing/Configuring the sink
```

```
TwitterAgent.sinks.HDFS.type = hdfs
```

```
TwitterAgent.sinks.HDFS.hdfs.path = hdfs://localhost:9000/user/Hadoop/twitter_data/
```

```
TwitterAgent.sinks.HDFS.hdfs.fileType = DataStream
```

```
TwitterAgent.sinks.HDFS.hdfs.writeFormat = Text
```

```
TwitterAgent.sinks.HDFS.hdfs.batchSize = 1000
```

```
TwitterAgent.sinks.HDFS.hdfs.rollSize = 0
```

```
TwitterAgent.sinks.HDFS.hdfs.rollCount = 10000
```

```
# Describing/Configuring the channel TwitterAgent.channels.MemChannel.type = memory
```

```
TwitterAgent.channels.MemChannel.capacity = 10000
```

```
TwitterAgent.channels.MemChannel.transactionCapacity = 100
```

```
# Binding the source and sink to the channel
```

```
TwitterAgent.sources.Twitter.channels = MemChannel
```

```
TwitterAgent.sinks.HDFS.channel = MemChannel
```

chinna samyad@gmail.com

Apache Flume

In the bin folder of flume_installation, give the below command

```
$ ./flume-ng agent --conf ../conf/ -f ../conf/twitter.conf Dflume.root.logger=DEBUG,console -n TwitterAgent
```



MapR Architecture

MapR-FS and HDFS

MapR-FS is an implementation of HDFS.

HDFS API's are compliant with MapR-FS.

MapR-FS, written in C, is a POSIX compliant read-write file system

MapR-FS : No Namenode. The metadata is distributed across the cluster.
So SPOF is eliminated.

MapR Architecture

Data is written to containers. Container are managed by CLDB.
CLDB - Container Location Database.

MapR-FS Client talks to CLDB to assign in container to write in data.

MAPR writes data to Container through chunks. Each chunk is of 256 MB writing at 8 KB per IO write. 256 MB is the default block size when compared to HDFS block size of 64 MB.

Unit of sharding	: Chunk - 256 MB
Unit of Replication	: Container - 32 GB
Unit of disk I/O	: Block - 8 KB

MapR Architecture

Storage Pools - A Storage pool consists of many disks grouped together.
Three disks are pooled together by default.

Containers reside on storage pool. Each storage pool can store many containers. The default container size is 32 G. Container is replicated three times by default.

cldb.container.sizemb

Each container contain directories, tables, files, data blocks and metadata.

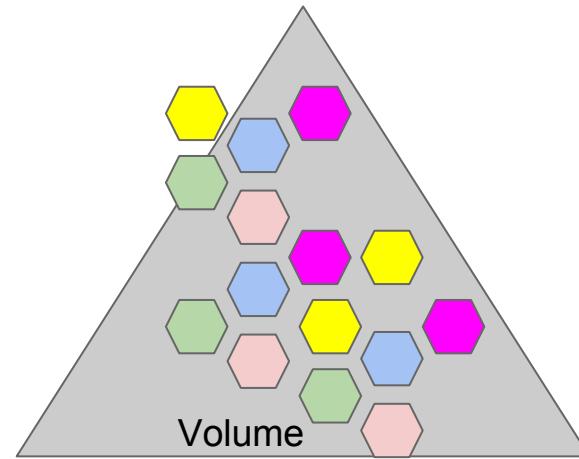
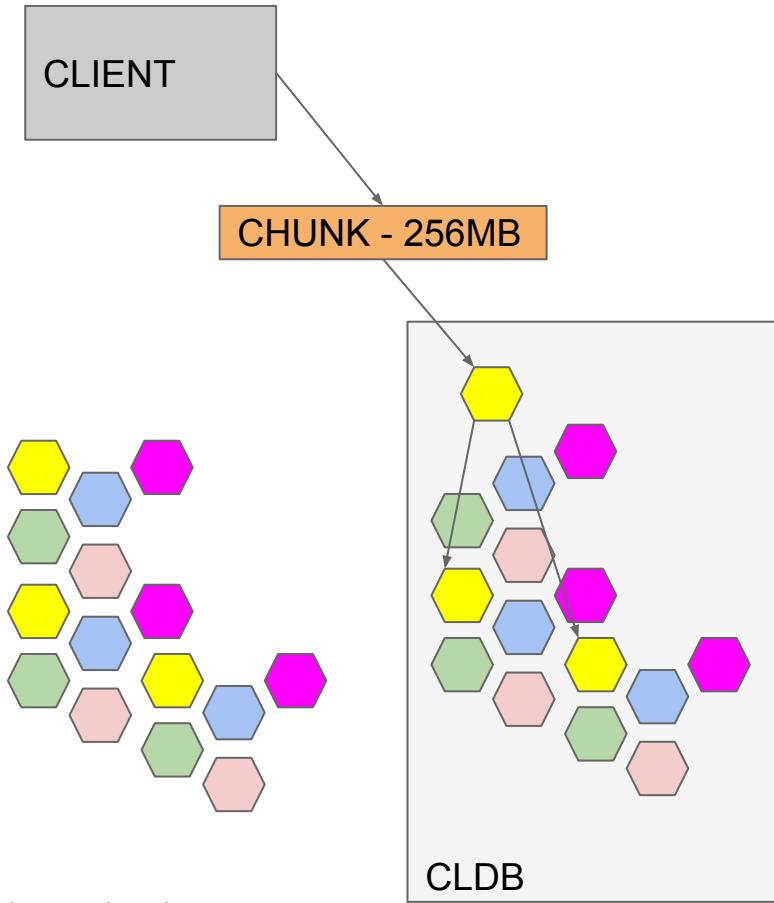
A volume is a group of containers.

MapR Architecture

CLDB is Container Location Data Base is a management service which finds out containers and root of volume.

CLDB only locates containers, not files and directories.

MapR Architecture



MapR Architecture

```
idapp@MNDCTEC2B10 conf]$ cat warden.conf
rvice=webserver:all:cldb:jobtracker:1:cldb:t_sktracker:all:jobtracker;nfs:all:cldb;kvstore:all:cldb:all:kvsto
rvice.command.jt.start=/opt/mapr/hadoop/hadoop-0.20.2/bin/hadoop-daemon.sh start jobtracker
rvice.command.tt.start=/opt/mapr/hadoop/hadoop-0.20.2/bin/hadoop-daemon.sh start tasktracker
rvice.command.hbmaster.start=/opt/mapr/hbase/hbase-0.94.17/bin/hbase-daemon.sh start master
rvice.command.hbregion.start=/opt/mapr/hbase/hbase-0.94.17/bin/hbase-daemon.sh start regionserver
rvice.command.cldb.start=/etc/init.d/mapr-cldb start
rvice.command.kvstore.start=/etc/init.d/mapr-mfs start
rvice.command.mfs.start=/etc/init.d/mapr-mfs start
rvice.command.nfs.start=/etc/init.d/mapr-nfsserver start
rvice.command.hoststats.start=/etc/init.d/mapr-hoststats start
rvice.command.webserver.start=/opt/mapr/adminuiapp/webserver start
rvice.command.jt.stop=/opt/mapr/hadoop/hadoop-0.20.2/bin/hadoop-daemon.sh stop jobtracker
rvice.command.tt.stop=/opt/mapr/hadoop/hadoop-0.20.2/bin/hadoop-daemon.sh stop tasktracker
rvice.command.hbmaster.stop=/opt/mapr/hbase/hbase-0.94.17/bin/hbase-daemon.sh stop master
rvice.command.hbregion.stop=/opt/mapr/hbase/hbase-0.94.17/bin/hbase-daemon.sh stop regionserver
rvice.command.cldb.stop=/etc/init.d/mapr-cldb stop
rvice.command.kvstore.stop=/etc/init.d/mapr-mfs stop
rvice.command.mfs.stop=/etc/init.d/mapr-mfs stop
rvice.command.nfs.stop=/etc/init.d/mapr-nfsserver stop
rvice.command.hoststats.stop=/etc/init.d/mapr-hoststats stop
rvice.command.webserver.stop=/opt/mapr/adminuiapp/webserver stop
rvice.command.jt.type=BACKGROUND
rvice.command.tt.type=BACKGROUND
rvice.command.hbmaster.type=BACKGROUND
rvice.command.hbregion.type=BACKGROUND
rvice.command.cldb.type=BACKGROUND
rvice.command.kvstore.type=BACKGROUND
rvice.command.mfs.type=BACKGROUND
rvice.command.nfs.type=BACKGROUND
rvice.command.hoststats.type=BACKGROUND
rvice.command.webserver.type=BACKGROUND
rvice.command.jt.monitor=org.apache.hadoop.mapred.JobTracker
rvice.command.tt.monitor=org.apache.hadoop.mapred.TaskTracker
rvice.command.hbmaster.monitor=org.apache.hadoop.hbase.master.HMaster start
rvice.command.hbregion.monitor=org.apache.hadoop.hbase.regionserver.HRegionServer start
rvice.command.cldb.monitor=com.mapr.fs.cldb.CLDB
rvice.command.kvstore.monitor=server/mfs
rvice.command.mfs.monitor=server/mfs
rvice.command.nfs.monitor=server/nfsserver
rvice.command.jt.monitorcommand=/opt/mapr/hadoop/hadoop-0.20.2/bin/hadoop-daemon.sh status jobtracker
```

MapR Architecture

Files =>

Chunks =>

Containers =>

Storage Pools =>

Disks => Nodes on the Disk

A container exactly belongs to one volume.

MapR - maprcli

maprcli is the MapR Command Line Interface for MapR Distribution of Hadoop

Lists the recent tables

```
$ maprcli table listrecent
```

MapR - maprcli

maprcli is the MapR Command Line Interface for MapR Distribution of Hadoop

Lists the recent tables

```
$ maprcli table listrecent
```

Container Location Database - CLDB UI

CLDB UI

<http://10.66.204.170:7221/>

CLDB UI runs on 7221 port by default.

The screenshot shows the CLDB UI interface. At the top, it displays the URL as 10.66.204.170:7221/cldb.jsp. The main title is "Container Location Database". Below it, the CLDB mode is listed as "MASTER_READ_WRITE". It also shows the CLDB BuildVersion as 3.1.0.23703.GA and the Master for CLDB volume ready as true. The CLDB Status is shown as "RUNNING" with details: Cluster Capacity at 974.65 GB, Cluster Used at 1.85 GB, Cluster Available at 972.8 GB, and Cluster Used Percentage at 0. The "Active FileServers" section contains a table with one row, showing the following data:

ServerID (Hex)	ServerId	HostPort	HostName	Network Location	Last Heartbeat (s)	State	Capacity (MB)	Used (MB)	Available (MB)	In Transit (MB)
13364b4c39c57cf0	1384376726221847805	10.66.204.170-10.67.204.170-192.168.122.1-	MNDCTEDC2B10	data/default-rack/MNDCTEDC2B10	0	ACTIVE	974.65 GB	1.85 GB	972.8 GB	0

Below the table, there is a section titled "Active NFS Servers" which is currently empty.



RabbitMQ Installation

The screenshot shows the Erlang download page at www.erlang.org/download.html. The top navigation bar includes links for NEWS, ARTICLES, EVENTS, DOWNLOADS, COMMUNITY, LINKS, DOCUMENTATION, and ABOUT. The DOWNLOADS menu is currently selected. Below the navigation, there's a section titled "DOWNLOAD OTP 18.1" with a cloud icon. It lists several download options for OTP 18.1, with the "OTP 18.1 Windows 64-bit Binary File (94.1 MB)" link highlighted by a red box.

RabbitMQ First needs erlang to be installed.
So install erlang first.

Erlang/OTP 18.1 has been released

[OTP 18.1 Readme File](#)

[OTP 18.1 Source File \(65.0 MB\)](#)

[OTP 18.1 Windows 32-bit Binary File \(93.6 MB\)](#)

[OTP 18.1 Windows 64-bit Binary File \(94.1 MB\)](#)

[OTP 18.1 HTML Documentation File \(32.4 MB\)](#)

[OTP 18.1 Man Pages File \(1.3 MB\)](#)

Some highlights of the release are:

- ssl: Add possibility to downgrade an SSL/TLS connection to a tcp connection, and give back the socket control to a user process.
- ssh: The following new key exchange algorithms are implemented: 'ecdh-sha2-nistp256', 'ecdh-sha2-nistp384', 'ecdh-sha2-nistp521', 'diffie-hellman-group14-sha1', 'diffie-hellman-group-exchange-sha1' and 'diffie-hellman-group-exchange-sha256'. This raises the security level considerably.

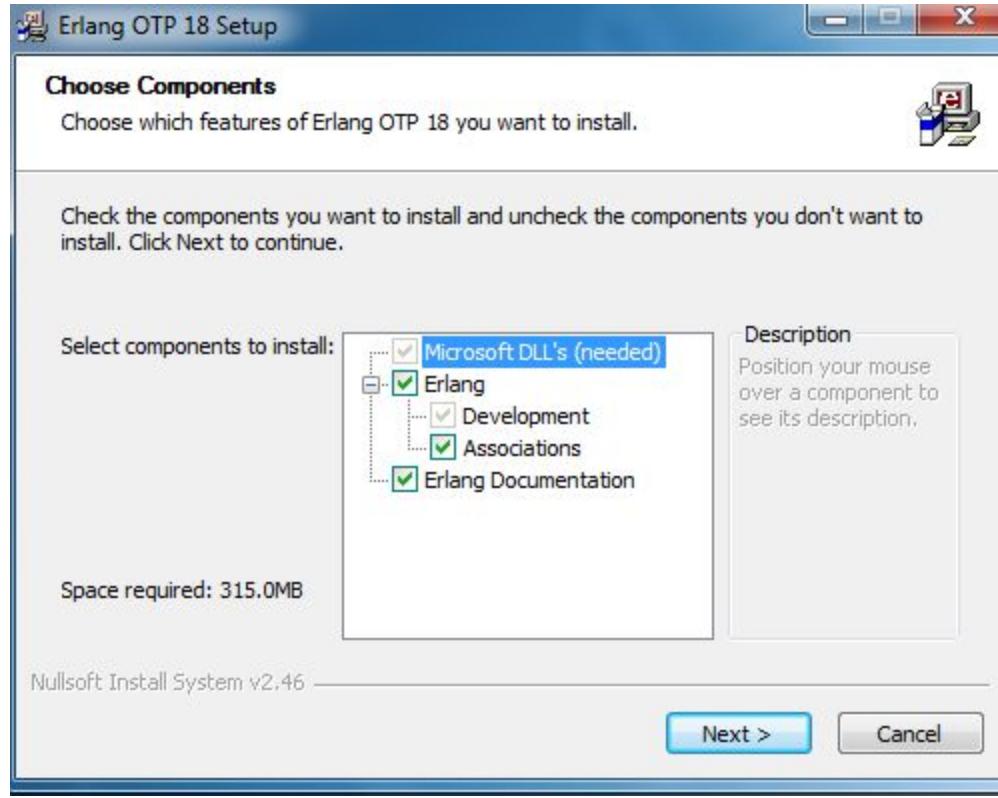
kernel,stdlib,sasl: A mechanism for limiting the amount of text that the built-in error logger events will produce has been introduced. It is useful for limiting both the size of log files and the CPU time used to produce them.

This mechanism is experimental in the sense that it may be changed based on feedback. See config parameter `error_logger_format_depth` in the Kernel application.

Available releases

- OTP 18.1
- OTP 18.0
- OTP 17.5
- OTP 17.4
- OTP 17.3
- OTP 17.1
- OTP 17.0
- OTP R16B03-1
- R16B03
- R16B02
- R16B01
- R16B
- R16A
- R15B03-1
- R15B02
- R15B01
- R15B
- R14B04
- R14B03
- R14B02
- R14B01

RabbitMQ Installation



RabbitMQ Installation

https://www.rabbitmq.com/download.html

The screenshot shows the official RabbitMQ download page. At the top is a navigation bar with links for Features, Installation, Docs, Tutorials, Support (which is underlined in orange), Community, We're Hiring, and Blog. To the right is a search bar with a magnifying glass icon. A large blue watermark reading "Now download RabbitMQ and install it" is diagonally across the page. The main content area has a light orange background and contains sections for "RabbitMQ Server" (with download links for Windows, Debian/Ubuntu, Fedora/RHEL, and source), "Downloads on GitHub" (with similar links), "Installation Guides" (with links for Windows, Linux/Unix, and Mac OS X), and "Cloud" (with links for Amazon EC2, Cloud Foundry, and Pivotal Cloud Foundry). The sidebar on the right is titled "In This Section" and lists various installation guides for different platforms like Windows, Debian, RPM-based Linux, Mac OS X, Homebrew, and EC2.

RabbitMQ™

Features Installation Docs Tutorials **Support** Community We're Hiring Blog

Search RabbitMQ

Downloading and Installing RabbitMQ

The latest release of RabbitMQ is 3.5.6.

RabbitMQ Server

Downloads on rabbitmq.com

> Windows | Debian / Ubuntu | Fedora / RHEL | Binary .tar.gz .zip | Source .tar.gz .zip

Downloads on GitHub

> Windows | Debian / Ubuntu | Fedora / RHEL | Binary .tar.gz .zip

Installation Guides

> Windows: With installer (recommended) | Manual
> Linux / Unix: Debian / Ubuntu | Fedora / RHEL | Generic Unix | Solaris
> Mac OS X: Standalone | Generic Unix | Homebrew

Cloud

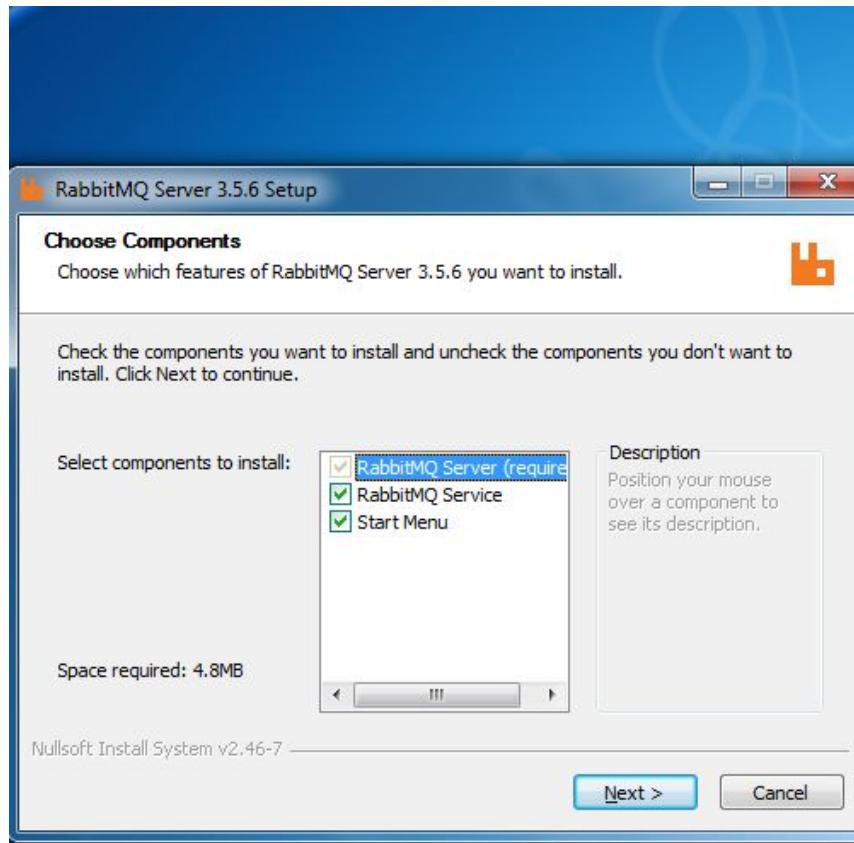
> Amazon EC2
> Cloud Foundry
> Pivotal Cloud Foundry

[rabbitmq.com/services.html](#)

In This Section

- > Install: Windows
- > Install: Debian / Ubuntu
- > Install: RPM-based Linux
- > Install: Mac OS X
- > Install: Homebrew
- > Install: Windows (manual)
- > Install: Generic Unix
- > Install: Solaris
- > Install: EC2
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- > Changelog
- > Erlang Versions
- > Signed Packages
- > Java Client Downloads
- > .NET Client Downloads
- > Erlang Client Downloads
- > Community Plugins

RabbitMQ Installation



RabbitMQ Commands

Returns the status of the server

\rabbitmq_server-3.5.6\sbin>*rabbitmqctl.bat status*

RabbitMQ Commands

```
Status of node 'rabbit@2400002720-LT33' ...
[{pid,5016},
 {running_applications,[{rabbit,"RabbitMQ","3.5.6"},
    {mnesia,"MNESIA CXC 138 12","4.13.1"},
    {os_mon,"CPO CXC 138 46","2.4"},
    {xmerl,"XML parser","1.3.8"},
    {sasl,"SASL CXC 138 11","2.6"},
    {stdlib,"ERTS CXC 138 10","2.6"},
    {kernel,"ERTS CXC 138 10","4.1"}]},
 {os,{win32,nt}},
 {erlang_version,"Erlang/OTP 18 [erts-7.1] [64-bit] [smp:4:4] [async-threads:30]
 \n"},
 {memory,[{total,37069616},
    {connection_readers,0},
    {connection_writers,0},
    {connection_channels,0},
    {connection_other,2712},
    {queue_procs,2712},
    {queue_slave_procs,0},
    {plugins,0},
    {other_proc,13575040},
...
...
...
```

RabbitMQ Installation



Agenda

Era of Functional Programming

Functional Interfaces

Lambda Expressions

Stream API

Functional Programming

The era of functional programming

Functional programming is a programming paradigm (a style of coding)

JDK 8 effectuates functional programming with the help of functional interfaces.

Usage of lambda expressions in the functional programming style makes the code more elegant and supreme.

Functional Interfaces

Functional Interfaces also called as Single Abstract Method (SAM) is an interface that contains only one abstract method.

Functional Interfaces may contain one or more default methods or static methods.

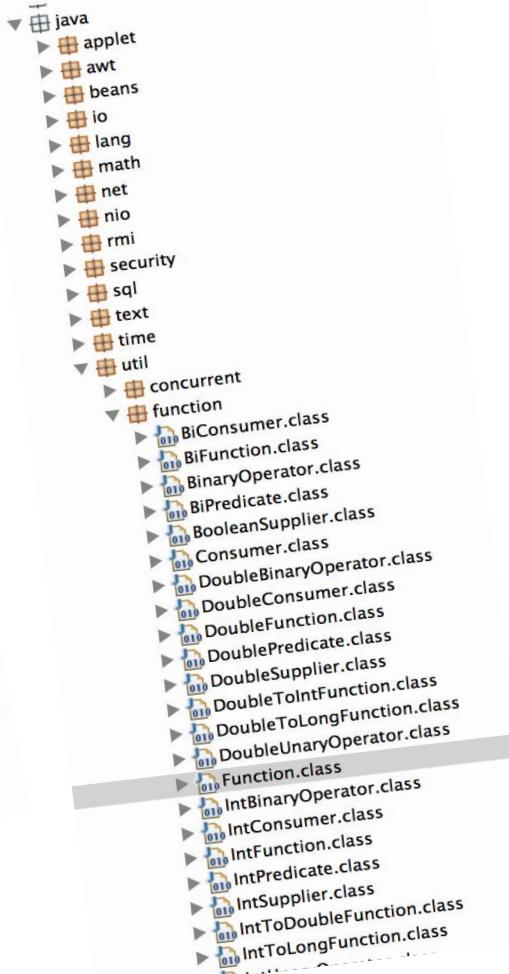
A marker interface is an empty interface whereas a functional interface is an interface with one method.

Functional Interfaces

```
38 * @since 1.8
39 */
40 @FunctionalInterface
41 public interface Function<T, R> {
42     /**
43      * Applies this function to the given argument
44      *
45      * @param t the function argument
46      * @return the function result
47      */
48     R apply(T t);
49
50     /**
51      * Returns a composed function that first
52      * Returns a composed function that first
```



```
36 *
37 * @since 1.8
38 */
39 @FunctionalInterface
40 public interface Predicate<T> {
41     /**
42      * Evaluates this predicate on the given argument.
43      *
44      * @param t the input argument
45      * @return {@code true} if the input argument matches the predicate,
46      * otherwise {@code false}
47      */
48     boolean test(T t);
49
50     /**
51      * Returns a composed predicate that first
```



Simple Functional Program

```
public class IsItAValidYamlDocument implements Predicate<String> {  
    @Override  
    public boolean test(String yamlDocument) {  
        return true;  
    }  
}  
  
import java.util.function.Function;  
public class YamlReaderFunction implements Function<String, Yaml> {  
    @Override  
    public Yaml apply(String yamlDocument) {  
  
        Yaml yaml = new Yaml();  
        // Do complex operations on the Yaml and then return Yaml object.  
        return yaml;  
    }  
}
```

The Lambda Expression

A lambda expression is a function without a declaration which is passed as a block of code to a place where an object is expected and the expected object is of type functional interface.

A lambda expression is an anonymous function that is treated as an instance of a functional interface.

A definitive epitome programming style that dates back to lisp style of programming.

The Lambda Expression

A lambda expression is expressed by the below mentioned syntax

(x , y, z, , , ...) -> <program_logic>

Simplest Lambda Expression Program

```
List<String> listOfStrings = new ArrayList<String>();  
listOfStrings.add("Dhara");  
listOfStrings.add("Bose");  
listOfStrings.add("Che");  
  
listOfStrings.forEach((z) -> System.out.println(z));
```

Lambda Expression Program

```
List<String> countries = new ArrayList();
countries.add("India");
countries.add("Pakistan");
countries.add("Srilanka");
```

```
List<String> filteredListOfStrings = countries
    .parallelStream()
    .filter((z) -> z.startsWith("S"))
    .collect(Collectors.toList());
```

Lambda Expression for a Thread

```
Runnable runnable = () -> {  
    for (;;) {  
        System.out.println("I am inside the thread");  
    }  
};  
  
new Thread(runnable).start();
```

Stream API

A stream is obtained as a source from the collections API components.

A stream is composed of one or more intermediate operation and one terminal operation.

Stream is obtained from a source and then one or many intermediate operation is performed and then followed by a terminal operation.

Stream API

```
import java.util.Arrays;  
  
Path[] paths = FileUtil.stat2Paths(files);  
  
Arrays.stream(paths)  
    .forEach(path -> System.out.println(path.getName()));
```

How to get in the total number of processors in Java ?

The `availableProcessors()` method in the `Runtime` class gives in the number of processors available to the JVM.

It is accessed by `Runtime.getRuntime().availableProcessors()`.

Any distributed java based system would use in this property to leverage the multi-core capability.

How to get in the total number of processors ?

In Scala:

```
val cpus = Runtime.getRuntime.availableProcessors()  
println(cpus)
```

In linux:

```
$ lscpu  
Or  
$ sysctl --all | grep cpu
```

In mac

```
$ sysctl -n hw.cpu  
$ sysctl -a | grep cpu
```



Install python

Vanilla Install:

<https://www.python.org/downloads/>

Anaconda Install:

<https://repo.continuum.io/archive/>

Python IDE



Download pycharm from:

<https://www.jetbrains.com/pycharm/download/#section=linux>

Python

Python is an interpreted,
object-oriented and high level language.

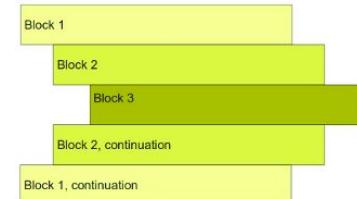
With the advent of machine-learning guys using, the language has become more popular.

Python

- > Created by Guido Van Rossum, a Dutch programmer from Netherlands.
- > General purpose programming language.
- > Of course, OPEN SOURCE.

Python

- A language structured with **indentation**, meaning code blocks are defined by their indentation.
- In python, indentation is matter of **language requirement** not a matter of style as compared to other programming languages.



print statement

You can use a single quote or double quote

```
print ('Hello Chola')
```

```
print ("Hello Chola")
```

Comment

Single line comment

"" Three quotes for multi line comment

""

Multiline

comment

""

IPython

To start the notebook, start it using the below command:

```
$ jupyter notebook
```

Datatypes and Collections

Numeric

Float

String

Boolean

List

Tuple

Set

Dictionary

Refer [pythondatatypes.py](#)

Variables

Defining a float

```
height = 100.1
```

Defining a string

```
name = "Chinnasamy"
```

Defining a int

```
weight = 30
```

```
//<type 'float'>
print type(height)
```

```
//<type 'str'>
print type(name)
```

```
<type 'int'>
print type(weight)
```

Variables

```
height = 100.1
name = "Chinnasamy"
weight = 30

multi_line_string_definition = """ This is
    a multi
        line string definition"""

print type(height)
print type(name)
print type(weight)

print (multi_line_string_definition)
```

Multiple assignments

Can do multiple assignments in a single line

```
tensor_data,reckoner_data=1065,56          # means tensor_data=1065,reckoner_data=56
```

Conversion of datatypes

```
tensor_int = 104  
tensor_float = 105.90  
tensor_string = "106"
```

```
convert_string_to_int = int(tensor_string)  
convert_int_to_float = float(tensor_int)  
convert_float_to_int = int(tensor_float)  
  
print (convert_string_to_int)  
print (convert_int_to_float)  
print (convert_float_to_int)
```

Output:

106
104.0
105

Datatypes

Number

String

List

Tuple

Dictionary

Strings

```
# String can be assigned with single or double quotes
string_variable = 'Aravindh'
another_string_varibale = "Chinnasamy"
```

```
# String concatenation
my_name = string_variable + another_string_varibale

print(my_name)
```

Numbers

```
number_variable = 2016
```

```
" Arithmetic Operations " # a comment
addition = 2 + 2
subtraction = 5 - 3
multiplication = 5 * 6
division = 4 / 2
remainder = 5 % 3
square = 2 ** 3
quotient = 5 // 3
```

```
# Formatting a print statement
print("Addition = %s" % "hi")
print("Addition = %s" % addition)
```

Refer pythondatatypes.py

Boolean

```
is_metadata_populated = True
print type(is_metadata_populated)  The line prints # <type 'bool'>
```

Refer pythondatatypes.py

List

List is created using []

```
list_of_contrats = ['echencier_1','echencier_2','echencier_3']
print list_of_contrats
```

Tuple

A tuple is a one dimensional,
fixed length,
Immutable sequence of python objects of ANY type.

Tuple

Tuple is created using (). With or without the brackets. Both are legal definitions of tuple.
A tuple is iterated through a for loop.

```
# Both of the below are legal declaration of tuple
```

```
investment_ratio_tuple = ("accounting_classification", "ifrs9.2", "embargo_check")
investment_ratio_tuple_aliter = "accounting_classification", "ifrs9.2", "embargo_check"
```

```
for each in investment_ratio_tuple_aliter:
    print(each)
```

```
list_of_time_line = ('timeline_1','time_line_2','time_line_3')
print list_of_time_line
```

Tuple - Operations

```
referential_investment_banking = "RefModeleNotation", "RefCommercial", "RefObjectNotation"  
referential_private_banking = "RefDevice", "RefNatural", "RefEmbargo"
```

Concatenate a tuple

```
referential_all = referential_investment_banking + referential_private_banking  
  
for each in referential_all:  
    print(each)
```

Unpack a tuple

```
ref_device, ref_natural, ref_embargo = referential_private_banking  
print(ref_device)
```

Dictionary - Associative arrays

Dictionary is created using { key : value }

```
country_code = {'IN':'INDIA','SL':'SRILANKA','CM':'CAMEROON'}
```

```
print country_code
```

```
METROLINX_TABLES = {  
  
    'OR0'   : "RVN_PROD.RAMS_PRESTO_USAGE_TEMP",  
    'OR1'   : "RVN_PROD.RAMS_PRESTO_SALESTRAN",  
    'OR2'   : "RVN_PROD.RAMS_PRESTO_USAGE",  
  
    'HI1'   : "RAMS_PRESTO_USAGE_TEMP",  
    'HI2'   : "PROD.RAMS_PRESTO_SALESTRAN",  
    'HI3'   : "PROD.RAMS_PRESTO_USAGE",  
  
    'HI4'   : "bi_opd_stop_ext",  
    'HI5'   : "bi_opd_trip_ext",  
    'HI6'   : "nom_vehicle_ext",  
    'HI7'   : "nom_vehicle_type_ext",  
    'HI8'   : "veh_stop_detail_ext",  
    'HI9'   : "veh_stop_ext",  
    'HI10'  : "veh_trip_ext",  
  
    'C1'    : "BI_OPD_STOP_Modified",  
    'C2'    : "NOM_VEHICLE_Modified",  
    'C3'    : "NOM_VEHICLE_TYPE_Modified",  
    'C4'    : "VEH_STOP_Modified",  
    'C5'    : "VEH_STOP_DETAIL_Modified",  
    'C6'    : "VEH_TRIP_Modified"  
}
```

Dictionary - Associative arrays

Iterating a dictionary

```
for key, value in metro_dict.iteritems():
    print(key + ' ' + value)
```

Returns the keys and values as List

```
print(metro_dict.keys())
print(metro_dict.values())
```

Get the value for the dictionary

```
print(metro_dict.get('C1'))
```

Get the value using DEFAULT

```
print(metro_dict.get('C9', "DEFAULT"))
```

Get the value for the dictionary

```
print(metro_dict['C1'])
```

Update the element of the dictionary

```
metro_dict['C1'] = 'BI_START'
```

Insert the element to the dictionary

```
metro_dict['C5'] = 'NOM_START'
```

```
print(metro_dict['C1'])
```

```
print(metro_dict['C5'])
```

Dictionary - Associative arrays

```
# Delete a key in hash map  
del metro_dict['C1']
```

```
# Creating dictionary from sequence  
# Use the zip transformation and dict to create the
```

```
key_table = ['C1', 'C2', 'C3']  
  
value_table = ["BI_OPD_STOP_Modified", "NOM_VEHICLE_Modified",  
"NOM_VEHICLE_TYPE_Modified"]  
  
metro_dict = dict(zip(key_table, value_table))
```

Dictionary - Associative arrays

```
# Check if a key exists.  
print ('C10' in metro_dict)
```

```
if 'C3' in metro_dict:  
    print("Element is in Dictionary")  
else:  
    print('Element is not in Dictionary')
```

```
new_dict = {"B1": "NOM", "B2": "NOM2"}  
  
# metro_dict is added with the elements of new_dict
```

```
metro_dict.update(new_dict)  
  
print(metro_dict)
```

Sets

A Set is an unordered collection of UNIQUE elements.

Sets are mutable.

Sets are created using list.

```
set_of_integers = set([1,2,4,4,2,5,6,2,1])  
print ("Printing a set %s" % set_of_integers)
```

Refer pythondatatypes.py

Sets

Set declaration

```
deep_learning_neuron_set = set(['neuron_solo', 'multi_perceptron', 'multi_perceptron', 'RNN'])  
deep_learning_neuron_set_aliter = {'neuron_solo', 'multi_perceptron', 'multi_perceptron', 'RNN'}
```

```
deep_learning_neuron_subset = set(['neuron_solo', 'multi_perceptron', 'multi_perceptron'])
```

```
deep_learning_neuron_superset = set(['neuron_solo', 'multi_perceptron', 'multi_perceptron', 'RNN', 'neural_network_algorithms'])
```

Find the super set and subset

```
print(deep_learning_neuron_subset.issubset(deep_learning_neuron_set))
```

```
print(deep_learning_neuron_superset.issuperset(deep_learning_neuron_set))
```

Refer pythondatatypes.py

frozensets

frozensets are immutable.

```
set_of_frozen_list = frozenset([1,2,4,3,2,3,2,1,7,9,7,8])  
print ("Printing a frozen set %s" % set_of_frozen_list)
```

Refer [pythondatatypes.py](#)

Conditions and Statements

if statement

```
age = 30
```

```
if (age > 19):  
    print("You are a teenager")  
else:  
    print("You are not a teenager")
```

Pass variable

The pass statement is a null operation.

Exceptions

Exceptions are written using the following keywords:

```
try  
except  
else  
finally
```

Exceptions

```
try:  
    f = open("a.txt")  
  
except IOError as e:  
    print('File is not found. Exception is %s' % e)  
  
else:  
    pass  
  
finally:  
    pass
```

Multiple Declaration is allowed

```
# Multiple Assignments in single line
_auaCode_, _auaName_, _auaValue = 1001, "TN", "LICENSED"

print _auaCode_
print _auaName_
print _auaValue
```

Obtaining value from command line

```
data_input = input("Enter the value = ")  
print(data_input)
```

Refer pythondatatypes.py

Conditions and Loops

for loop

```
deep_learning_model_list = ["scalar", "vector", "matrix", "tensor"]
```

```
# Iterating a for with each element
for each in deep_learning_model_list:
    print each
```

```
# Iterating a for with index of each element
for index in range(len(deep_learning_model_list)):
    print deep_learning_model_list[index]
```

while loop

While loop:

```
count = 0

while (count < 30):
    print ("The count is :" + str(count))
    count = count + 1

print("While loop is done")
```

While loop with else:

```
i = 1

while (i < 10):
    print (str(i) + "is less than 10")
    i = i+1
else:
    print (str(i) + "is greater than 10")
```

while loop

While loop - Infinite loop:

```
# Infinite loop
counter = 1

while counter == 1:
    print ("Printing the counter :")
```

Functions

Functions

Blocks of related code which are reusable.

Types:

- Pre-defined functions. eg.print()
- User-defined functions

Functions

User-defined functions

Syntax:

```
def function_name(list_of_arguments):
```

```
    return
```

Functions - Simple Function

```
def logWarn(warnMessage):  
    print warnMessage  
    return
```

Functions - Types of writing functions

- Required arguments
- Keyword arguments
- Default arguments
- Variable-length arguments

Refer [pythondatatypes.py](#)

Functions - Required arguments

Same number and order of arguments in function call and function definition.

```
def metadata_reckoner(data, operations):
    print data
    return

metadata_reckoner("AclList", "find")      #function call
```

Refer [pythondatatypes.py](#)

Functions - Keyword arguments

Order of arguments in function calls and definition need not be same, provided argument name is given in function call

```
def metadata_reckoner(data, operations):
    print data
    return

metadata_reckoner(operations="find",data="AclList") #function call
```

Refer [pythondatatypes.py](#)

Functions - Default arguments

Default values can be given for arguments in function definition

If a new value is given for same argument in function call, the new value gets considered

Order of assigning default values is from right to left.

```
def ingest_to_hive(query, schema="DEV"):
    print query
    return

ingest_to_hive("insert")           #function call
ingest_to_hive("insert","DEVAPP")
```

Refer pythondatatypes.py

Functions - Variable-length arguments

Can give more number of arguments than given in function definition

Variable name preceded by * holds the variable number of arguments

```
def tensor_data(*tensor_vector):
    for t_data in tensor_vector:
        print t_data
    return
```

Refer pythondatatypes.py

Functions - Lambda Expression

Functions using lambda keyword instead of def. Was added in the later versions of python.

Syntax:

lambda var1,var2 : expression

var1, var2 are variables used in the function.

expression is the operation to be performed over the variables.

Refer [pythondatatypes.py](#)

Functions - Lambda Expression

[1] Writing the first lambda expression function

```
add = lambda x,y : x+y  
value = add(5,6)  
print (value)
```

[2] Lambda expressions having a default value

```
multiply_with_five = lambda x,y=5 : x*y  
value = multiply_with_five(6)  
value = multiply_with_five(6,5) #This is also legal  
print (value)
```

Refer pythondatatypes.py

Functions - Anonymous functions - Lambda Expressions

```
uid_aggregator=lambda uid,default=100: uid+default
```

```
new_uid=uid_aggregator(2387)  
print new_uid
```

Refer pythondatatypes.py

Functions - Lambda Expressions - if elif else

```
# Lambda with if and elif and else
return_me_word = lambda x : "five" if x == 5 else "none"

return_me_words = lambda x : "five" if x == 5 else ( "four" if x==4 else ("three" if x==3 else "none"))

print(return_me_words(5))
print(return_me_words(4))
```

Functions - Types of writing functions.

Examples

```
def simple_function():
```

```
    print("Inside the simple function")  
    return 0
```

```
def function_with_parameter(name) :
```

```
    print ("Name is %s" % name)  
    return
```

```
def function_with_default_parameter(id, algorithm="gini"):
```

```
    print ("ID and name is %s and %s" % (id, algorithm))  
    return
```

Functions - Types of writing functions.

Examples

```
def function_with_var_args(*arguments):
    #print(arguments)

    for each in arguments:
        print each

    return

print(simple_function())
function_with_parameter("Gini Impurity")
function_with_default_parameter(101)
function_with_default_parameter(102,"logarithmic")
function_with_var_args("arg1","arg2","arg3")
```

Python modules

A module is a file (.py) containing definitions or statements.

Logical grouping of statements or expressions in a python file.

Packages

Packages are grouping of modules logically.

Refer [pythondatatypes.py](#)

Transformations in Python

map(),filter(),reduce()

map() function:

- `map(user_defined_function, any_collection)`

`map()` applies the `user_defined_function` to all the elements of `any_collection`(list,tuple etc.). It returns a new list with the elements changed by the function.

- `map(lambda_expression, any_collection)`

Uses `lambda_expression` that avoids creation of a user-defined function. It returns a new list with the elements changed by the `lambda_expression`.

map(): user_defined_function as argument

```
#To convert the strings in the given list into uppercase
pentaho_acl_authorize_list=("GrantedAuthorityEffectiveAclsResolver",
                            "GrantedAuthority",
                            "AclEntry",
                            "IPentahoSession",
                            "WebPentahoObjectFactory")

def uppercase(st): #user-defined function to convert strings in given list into uppercase
    return st.upper()

pentaho_acl_authorize_uppercase_list=map(uppercase,
                                         pentaho_acl_authorize_list)

print pentaho_acl_authorize_uppercase_list
```

Output:
['GRANTEDAUTHORITYEFFECTIVEACLSRESOLVER', 'GRANTEDAUTHORITY', 'ACLENTRY', 'IPENTAHOSESSION', 'WEBPENTAHOOBJECTFACTORY']

map() : lambda expression as argument

```
pentaho_acl_authorize_list=("GrantedAuthorityEffectiveAclsResolver",  
                            "GrantedAuthority",  
                            "AclEntry",  
                            "IPentahoSession",  
                            "WebPentahoObjectFactory")
```

```
pentaho_acl_authorize_uppercase_list=map(lambda each_element: each_element.upper(),  
                                         pentaho_acl_authorize_list)
```

```
print pentaho_acl_authorize_uppercase_list
```

Output:

```
[GRANTEDAUTHORITYEFFECTIVEACLSRESOLVER', 'GRANTEDAUTHORITY', 'ACLENTRY', 'IPENTAHOSESSION', 'WEBPENTAHOOBJECTFACTORY']
```

filter() function:

- **filter(user_defined_function, any_collection)**

filter() extracts only the required elements from any_collection(list,tuple etc.) . It returns a new list with the elements that returns true for the given user_defined_function.

- **filter(lambda_expression, any_collection)**

Uses lambda_expression that avoids creation of a user-defined function. It returns a new list with the elements extracted from any_collection by the lambda_expression.

filter(): user_defined_function as argument

```
#To extract the strings in the given list that begins with 'G'
pentaho_acl_authorize_list=("GrantedAuthorityEffectiveAcIsResolver",
                             "GrantedAuthority",
                             "AclEntry",
                             "IPentahoSession",
                             "WebPentahoObjectFactory")

def string_starting_with_G(element):
    if (element.startswith("G")):
        return element

pentaho_acl_filtered_list=filter(string_starting_with_G, pentaho_acl_authorize_list)

print pentaho_acl_filtered_list
```

Output:('GrantedAuthorityEffectiveAcIsResolver', 'GrantedAuthority')

filter(): lambda_expression as argument

```
#To extract the strings in the given list that begins with 'G'  
pentaho_acl_authorize_list=("GrantedAuthorityEffectiveAclsResolver",  
                             "GrantedAuthority",  
                             "AclEntry",  
                             "IPentahoSession",  
                             "WebPentahoObjectFactory")  
  
pentaho_acl_filtered_list=filter(lambda element:element.startswith("G"), pentaho_acl_authorize_list)  
  
print pentaho_acl_filtered_list
```

Output:('GrantedAuthorityEffectiveAclsResolver', 'GrantedAuthority')

reduce() function:

- `reduce(user_defined_function, any_collection)`

`reduce()` performs the given function on all the elements of the collection and returns only one value as result.

- `reduce(lambda_expression, any_collection)`

reduce() function:

```
list=[e1,e2,e3,e4,e5,e6,e7,e8]
```

```
reduce(fn, list)
```

When a function fn is applied on the list using the reduce() reduction operation, the following steps of algorithm takes place:

Step 1: fn(e1,e2)

Step 2: fn (fn(e1,e2) , e3)

Step 3: fn(fn (fn(e1,e2) , e3), e4)

reduce(): user_defined_function as argument

```
trip_details_list = [100, 34, 56, 67, 89]

def fn_count_of_trip_details(agg_first,agg_second):
    return agg_first+agg_second

count_of_trip=reduce(fn_count_of_trip_details,trip_details_list)

print "total=",count_of_trip
```

Output: Total= 346

reduce(): lambda_expression as argument

```
trip_details_list = [100, 34, 56, 67, 89]  
fn_count_of_trip_details =lambda agg_first,agg_second: agg_first+agg_second  
count_of_trip=reduce(fn_count_of_trip_details, trip_details_list)  
print count_of_trip
```

Output:346

reduce(): finding the maximum element

```
# Finding the maximum element using the reduce transformation
elements = [34,67,45,98,23,44,67,88]
maximum_element = lambda first,second: first if (first > second) else second
print(reduce(maximum_element, elements))
```

Classes

```
class Name_Of_Class:  
  
    def __init__(self):  
  
        def method_name:  
  
            def another_method(self, parameter):
```

To instantiate a class:

```
variable_name = Name_Of_Class()  
variable_name.method_name  
variable_name.another_method('Chinnasamy')
```

Classes

```
class ReadCSVFile:  
  
    def __init__(self):  
        print("Constructor Initialized")  
  
    def printFileName(self, fileName):  
        print("Inside printFileName - " + fileName)
```

ReadCSVFile.py

```
readCSVFile = ReadCSVFile()  
readCSVFile.printFileName('FILE-001')
```

Classes

```
class ReadFile:  
  
    def __init__(self, _name_of_file_):  
        self.name_of_file = _name_of_file_  
  
    def readfile(self):  
        resumeTikaFile = open(self.name_of_file, "r")  
        return resumeTikaFile.read(99999)
```

Classes- Constructor and destructor

`__init__()` is the constructor function that gets invoked when object is created for the class

`del` keyword invokes the destructor

`__del__()` is the destructor function

Classes- Constructor and destructor

```
class FaceRecognitionTensor:  
  
    global_face_threshold = 0  
  
    def __init__(self):  
        print(self.global_face_threshold)  
        print "Constructor Initialized."  
  
    def compute_tensor(self):  
        return 78.8  
  
    def __del__(self):  
        print "Destructor Called."  
  
face_recognition_tensor = FaceRecognitionTensor()  
  
face_recognition_tensor.compute_tensor()  
  
del face_recognition_tensor
```

Classes - static methods

A static method does not require a class object to invoke it unlike other functions.

It is invoked using the class itself.

syntax:

CLASSNAME.static_method

Classes- Static methods

```
class FaceRecognitionTensor:
```

```
    global_face_threshold = 0
```

```
FaceRecognitionTensor.INITIALIZE()
```

```
@staticmethod  
def INITIALIZE():  
    global_face_threshold = 78  
    print "initialized..."
```

Class - Methods and Static Methods

```
class InvestmentConclave:  
  
    def __init__(self, _timeline_):  
        self.timeline = _timeline_  
  
    def computeSparkIngestion(self, run):  
        print(run)  
  
    @staticmethod  
    def save_in_hdfs(hdfs_data):  
        print(hdfs_data)  
  
in_conclave = InvestmentConclave("TimeLine")  
  
in_conclave.computeSparkIngestion("RUN SPARK")  
  
# Accessing static methods  
InvestmentConclave.save_in_hdfs("HDFS DATA")
```

Class Inheritance

```
class AbstractInvestment:
```

```
    def loadData(self, data):  
        print(data)
```

```
class Investment:
```

```
    def loadInvestments(self, data):  
        print data
```

```
class PrivateBanking(AbstractInvestment, Investment):  
    Pass
```

```
pb = PrivateBanking()
```

```
pb.loadData("DATA FROM PRIVATEBANKING")  
pb.loadInvestments("DATA FOR INVESTMENTS")
```

Garbage Collection

Garbage collection is the mechanism of freeing the memory in heap

The gc module in python provides APIs to interact with the garbage collector of python

Garbage Collection

```
import gc as gc

if __name__ == "__main__":
    # Runs the garbage collection
    gc.collect()

    # Provides the list of objects that the collector found to be
    # unreachable and could not be freed.
    gc.garbage

    # Is the garbage collection enabled
    gc.isenabled()

print(gc.isenabled())
```

Regular Expressions

Regular Expressions

The library `re` is regular-expression based library which can perform regular expression based solutions.

```
import re  
  
matches = re.findall(r'[\w\.-]+@[\\w\.-]+\.', self.filecontent)
```

The above code would give the email id's in the content.

Data DTO

```
class MetadataValue:  
  
    def __init__(self, **args):  
        self.__dict__ = args
```

```
metadatavalue = MetadataValue()  
metadatavalue.op_name = ""  
metadatavalue.job_type = ""
```

Enums

```
from enum import Enum

class OPTYPE(Enum):
    INGESTION      = 'Ingestion',
    CURATION       = 'Curation',
    TRANSFORMATION = 'Transformation',
    CONSUMPTION    = 'Consumption'

    def get_value(self):
        return self.value[0]

if (metadata_value.op_type == OPTYPE.INGESTION.get_value()):
    print "Ingestion Done"

class OPNAME(Enum):
    HIVE  = "Hive"
    BASH  = "Bash"
```

Enums

```
from enum import Enum

class METROLINX_TABLES(Enum):

    OR0 = 'RVN_PROD.RAMS_PRESTO_USAGE_TEMP',
    OR1 = 'RVN_PROD.RAMS_PRESTO_SALESTRAN',
    OR2 = 'RVN_PROD.RAMS_PRESTO_USAGE'

    HI1 = "RAMS_PRESTO_USAGE_TEMP",
    HI2 = "PROD.RAMS_PRESTO_SALESTRAN",
    HI3 = "PROD.RAMS_PRESTO_USAGE",

    HI4 = "bi_opd_stop_ext",
    HI5 = "bi_opd_trip_ext",
    HI6 = "nom_vehicle_ext",
    HI7 = "nom_vehicle_type_ext",
    HI8 = "veh_stop_detail_ext",
    HI9 = "veh_stop_ext",
    HI10 = "veh_trip_ext",

    C1 = "BI_OPD_STOP_Modified",
    C2 = "NOM_VEHICLE_Modified",
    C3 = "NOM_VEHICLE_TYPE_Modified",
    C4 = "VEH_STOP_Modified",
    C5 = "VEH_STOP_DETAIL_Modified",
    C6 = "VEH_TRIP_Modified",

    def get_value(self):
        return self.value[0]
```

Naming Convention

Module/package names	short, all lowercase, underscores only if needed	imp, sys
Function names	all lowercase, underscores_for_readability	foo(), my_func()
Variable names	all lowercase, underscores_for_readability	my_var
Class names	CapitalizeEachWord	MyClass
Constant names	ALL_CAPS_WITH_UNDERSCORES	PI, TAX_RATE

Indentation 4 spaces per level, don't use tabs Comparisons

File Handling

File

Open and read a file

Open the file in read mode. "r" represents the read mode.

```
resumeTikaFile = open(self.name_of_file, "r")
```

Then read the file using open(). The 99999 represents the number of bytes to be read.

```
resumeTikaFile.read(99999)
```

Reading an XML File

```
<metadata name="metrolinux">
  <operational_metadata title="operational">
    <op_type>3</op_type>
    <op_name>RAMS</op_name>
    <source_system>CSV</source_system>
    <source_path>/var/local/sys/rams.csv</source_path>
    <target_system>HDFS</target_system>
    <target_path>hdfs://localhost:9000/rams/ingest</target_path>
  </operational_metadata>
</metadata>
```

Reading an XML File

```
from xml.dom.minidom import parse
import xml.dom.minidom

DOMTree = xml.dom.minidom.parse("metrolinux_metadata_static.xml")

collection = DOMTree.documentElement

if collection.hasAttribute("name"):
    print "Root element : %s" % collection.getAttribute("name")

operational_metadata = collection.getElementsByTagName("operational_metadata")

for md in operational_metadata:

    type = md.getElementsByTagName('op_type')[0]
    print "source_system: %s" % type.childNodes[0].data
```

Reading an XML File

```
import xml.etree.ElementTree as ET
tree = ET.parse('/tmp/testfile.xml')

#tree = ET.fromstring(file_content_hdfs)

root = tree.getroot()
```

```
for data in root.findall('data'):
    for mt in data.findall('metadata_type'):
        #print mt.attrib
        for operations in mt.findall('operations'):
            for optype in operations.findall('op_type'):

                if (optype.get('name') == "transformation"):
                    for att in optype.findall('attribute'):

                        for each_element in list(att):

                            if (each_element.tag == "op_name"):
                                metadatavalue.op_name = each_element.text

                            elif (each_element.tag == "job_type"):
                                metadatavalue.job_type = each_element.text

                            elif (each_element.tag == "source_type"):
                                metadatavalue.source_type = each_element.text

                            elif (each_element.tag == "source_schema_name"):
                                metadatavalue.source_schema_name = each_element.text

                            elif (each_element.tag == "source_location"):
                                metadatavalue.source_location = each_element.text

                            elif (each_element.tag == "source_entity_name"):
                                metadatavalue.source_entity_name = each_element.text

                            elif (each_element.tag == "source_path"):
                                metadatavalue.source_path = each_element.text

                            elif (each_element.tag == "target_path"):
                                metadatavalue.target_path = each_element.text

return metadatavalue
```

Validate XML using XSD

```
from lxml import etree

def validateXMLUsingXSD(self, xsd_file, xml_file):
    xmlschema_doc = etree.parse(xsd_file)
    xmlschema = etree.XMLSchema(xmlschema_doc)

    xml_doc = etree.parse(xml_file)
    result = xmlschema.validate(xml_doc)

    return result
```

Writing to a FILE

```
file = open("/tmp/testfile.xml", "w")
file.write(file_content_hdfs)
file.close()
```

File_content_hdfs is just a string

Writing to a FILE

```
with open(file_location, 'w') as file:  
    for line in list_of_lines:  
        file.write(line)  
        file.write("\n")
```

line is a string here.

Deleting a FILE

```
import os  
os.remove("/path/to/file.csv")
```

Reading a file in a directory

```
with open("/directory/file.csv", 'r') as content_file:  
    content = content_file.read()
```

filecmp and dircmp

file cmp

It is to compare two filenames and return true if they match and returns false otherwise.

Syntax: filecmp.cmp(file1,file2,shallow)

Shallow is an optional argument that accepts either “True” or “False” as its values.

If **shallow=True**, checks for status of the files. If they are same returns true. Does not check contents of files.

If **shallow=False**, checks contents of files and returns true only if contents match.

The default is to perform a shallow comparison, without looking inside the files.

filecmp()

```
import filecmp

import filecmp
print(filecmp.cmp("/Users/dharshekthvel/mp/code/python/lamba/filterfunction.py",
                  "/Users/dharshekthvel/mp/code/python/lamba/filterwithlambda.py",
                  shallow=True))
#returns false as the names do not match

print(filecmp.cmp("/Users/dharshekthvel/mp/code/python/lamba/mapwithlambda.py",
                  "/Users/dharshekthvel/mp/code/python/lamba/mapwithlambda_copy.py",
                  shallow=False))
#returns true

print(filecmp.cmp("/Users/dharshekthvel/mp/code/python/lamba/mapfn.py",
                  "/Users/dharshekthvel/mp/code/python/lamba/mapfn_copy.py",
                  shallow=False))
# returns true--Compares contents of file when shallow=False
```

dircmp

The **dircmp** compares files by doing shallow comparisons

Syntax:

```
filecmp.dircmp(dir1,dir2,ignore,hide)
```

dir1 and dir2 are the two directories to be compared

Ignore and hide are optional parameters

Ignore by default ignores names like 'RCS', 'CVS', 'tags'

Hide by default hides names like os.curdir, os.pardir

Functions supported by dircmp class:

- left_list
- right_list
- left_only
- right_only
- common

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difflib

```
import difflib

dc = difflib.Differ().compare('/Users/dharshekthvel/mp/code/python',
'./PycharmProjects')

print 'Left_directory :', dc.left_list #prints Left : ['.DS_Store', '.git', '.idea', 'file_reckoner', 'lamba']

print 'Right_directory:', dc.right_list
#prints Right: ['.DS_Store', '.idea', 'collection', 'datatypes', 'extras', 'filehandling', 'glob',
'inheritance', 'pickleinpython', 'subprocess', 'untitled', 'untitled1']

print 'Left_only:', dc.left_only #prints [lamba', '.git', 'file_reckoner']

print 'Right_only:', dc.right_only #prints ['filehandling', 'inheritance', 'glob', 'untitled1', 'collection',
'subprocess', 'extras', 'pickleinpython', 'datatypes', 'untitled']

print 'common in both directories:', dc.common #prints [.idea', '.DS_Store']
```

difrcmp

```
# report_full_closure() is used for a detailed and a recursive comparison  
  
filecmp.difrcmp('/Users/dharshekthvel/mp/code/python',  
'/Users/dharshekthvel/PycharmProjects').report_full_closure()
```

Output:

```
diff /Users/dharshekthvel/mp/code/python /Users/dharshekthvel/PycharmProjects  
Only in /Users/dharshekthvel/mp/code/python : ['.git', 'file_reckoner', 'lamba']  
Only in /Users/dharshekthvel/PycharmProjects : ['collection', 'datatypes', 'extras', 'filehandling', 'glob', 'inheritance', 'pickleinpython', 'subprocess',  
'untitled', 'untitled1']  
Differing files : ['.DS_Store']  
Common subdirectories : ['.idea']  
  
diff /Users/dharshekthvel/mp/code/python/.idea /Users/dharshekthvel/PycharmProjects/.idea  
Only in /Users/dharshekthvel/mp/code/python/.idea : ['python.iml', 'vcs.xml']  
Only in /Users/dharshekthvel/PycharmProjects/.idea : ['PycharmProjects.iml']  
Identical files : ['misc.xml']  
Differing files : ['modules.xml', 'workspace.xml']
```

Serialization using pickle

```
import pickle

from dtopackage.aua_code import AuaCode

county_tuple = ("IN", "FR", "SL")

output = open("/home/dharshekthvel/ac/county.pkl", "wb")

pickle.dump(county_tuple, output)

output.close()
```

Pickling is the process of serializing an object in python

Deserialization using pickle

```
import pickle

inputFile = open("/home/dharshekthvel/ac/county.pkl", "r")

tuple1 = pickle.load(inputFile)

print tuple1

inputFile.close()
```

Sleep in python

```
from time import sleep  
sleep(15)
```

Make the current execution flow slow by 15 ms.

Time API

```
import time
import datetime

def get_current_time():
    ts = time.time()
    return datetime.datetime.fromtimestamp(ts).strftime("%Y-%m-%d %H:%M:%S")
```

glob

It returns a list of paths matching a Unix-style glob pattern.

```
import glob  
  
print glob.glob("/Users/dharshekthvel/downloads/*.html")
```

Output:

```
['/Users/dharshekthvel/downloads/launcher.aspx.html', '/Users/dharshekthvel/downloads/sitemap.html',  
 '/Users/dharshekthvel/downloads/SOA-108015120844-DECEMBER-2016.html',  
 '/Users/dharshekthvel/downloads/SOA-108015120844-OCTOBER-2016.html']
```

deque

Double ended queue data structure

Insertion and deletion done on both the sides

The operations that are supported in python are :

- `append()`
- `appendleft()`
- `pop()`
- `popleft()`
- `clear()`

deque

```
data=deque()

data.append('tensor_12')
data.append('tensor_13')
data.appendleft('tensor_0')
data.append('tensor_14')
data.append('tensor_svm')
print(data) #prints deque(['tensor_0', 'tensor_12', 'tensor_13', 'tensor_14', 'tensor_svm'])

data.pop()
print (data) #prints deque(['tensor_0', 'tensor_12', 'tensor_13', 'tensor_14'])

data.popleft()
print (data) #prints deque(['tensor_12', 'tensor_13', 'tensor_14'])

newmap=map(lambda each: print(each),data)
""prints tensor_12
tensor_13
tensor_14
"""

data.clear()
print (data) #prints deque([])
```

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Current User Name API

```
def get_current_linux_user_name():
    import getpass
    return getpass.getuser()
```

Parent Process ID - API

```
#  
# Returns the parent process name  
#  
def get_parent_process_id():  
    import os  
    return os.getppid()
```

dir() function

```
import pyspark  
print(dir(pyspark)) # List all methods available on the object
```

Output:

```
['Accumulator', 'AccumulatorParam', 'BasicProfiler', 'Broadcast', 'HiveContext', 'MarshalSerializer', 'PickleSerializer', 'Profiler',  
'RDD', 'Row', 'SQLContext', 'SparkConf', 'SparkContext', 'SparkFiles', 'SparkJobInfo', 'SparkStageInfo', 'StatusTracker',  
'StorageLevel', '__all__', '__builtins__', '__doc__', '__file__', '__loader__', '__name__', '__package__', '__path__', '__version__',  
'accumulators', 'broadcast', 'cloudpickle', 'conf', 'context', 'copy_func', 'files', 'find_spark_home', 'heapq3', 'java_gateway', 'join',  
'keyword_only', 'profiler', 'rdd', 'rddsampler', 'resultiterable', 'serializers', 'shuffle', 'since', 'sql', 'statcounter', 'status', 'storagelevel',  
'traceback_utils', 'types', 'version', 'wraps']
```

Execute an external command

```
import subprocess as sp
```

```
def execute_hdfs(filename):  
  
    result = sp.Popen(["hdfs", "dfs", "-cat", "/metrolinux_metadatav2.xml"], stdout=sp.PIPE).communicate()[0]  
  
    return result
```

```
def execute_query(query):  
  
    sp.Popen(query, shell=False, stdout=sp.PIPE)  
    return
```

REST

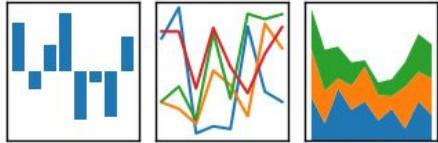
```
import requests

data = ""
{
    "name": "BNP",
    "location": {
        "lat": %d,
        "lon": 5
    }
}
range_of_counter = range(800, 1000)

for i in range_of_counter:
    url = 'http://localhost:9200/bgeo/banks/%d?pretty' % i
    for j in range(10, 36):
        response = requests.post(url, data=data)
        print("The response is - %s" % response.text)
```

pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$



API for reading, writing and manipulating data with the notion of dataframes.

Reading an excel file

```
import pandas as pd

# Read the file
master_file = pd.ExcelFile('/home/dharshekthvel/ac/code/scalatrainingintellij/data/sample.xls')

# Get the sheet names
sheets = master_file.sheet_names

# Get a particular sheet
survey = master_file.parse('choices')

# Print the rows from 0 to 13
print survey[0:13]

# Delete a particular column
del survey['name']

# Drop a particular column
new_survey = survey2.drop('caption', axis = 1)
```

Reading an excel file

```
# Make a deep copy of the dataframe  
  
new_survey = survey.copy(deep=True)
```

Flask

Python web server

Flask Base Program

```
from flask import Flask
app = Flask(__name__)

@app.route("/")
def rootrequest():
    return "Data-Ingestion Home Page"

@app.route("/data")
def data():
    return "Data-Ingestion Started"

$ export
FLASK_APP=/home/dharshekthvel/PycharmProcts/SparkBasic/flask_server/flask_server.py

$ flask run
```

Python – DATABASE

```
import MySQLdb

db = MySQLdb.connect(host="db4free.net", user="hector", passwd="hector", db="hectordb", port=3307)

cursor = db.cursor()

# execute SQL query using execute() method.
data = cursor.execute("SELECT * FROM OPERATIONAL_METADATA")

results = cursor.fetchall()
for row in results:
    op_id = row[0]
    op_name = row[1]

    print op_id, op_name

db.close()
```

Python – MATPLOTLIB

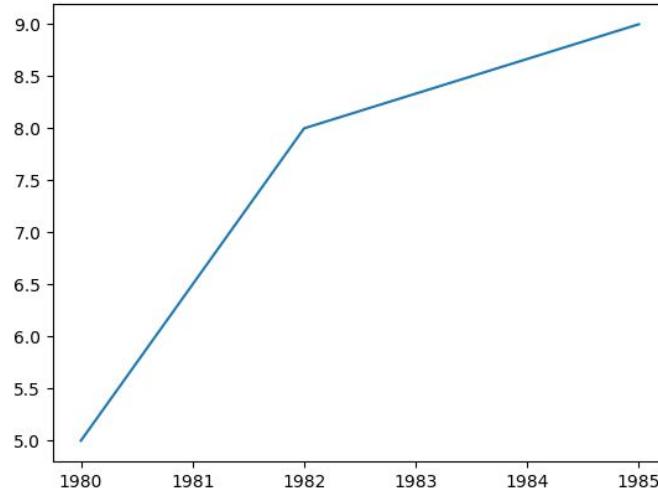
```
import matplotlib.pyplot as plt
```

```
year = [1980, 1982, 1985]
```

```
expectancy = [5, 8, 9]
```

```
plt.scatter(year, expectancy)
```

```
plt.show()
```



Python – MATPLOTLIB

```
import matplotlib.pyplot as plt  
  
year = [1980, 1982, 1985]  
  
expectancy = [5 ,8, 9]  
  
plt.plot(year, expectancy)  
  
plt.show()
```

Python Distributables

Build, Deploy

egg

```
from setuptools import setup, find_packages

setup (
    name='dmac',
    version='1.0.0',
    author='chinnasamy',
    packages = find_packages()

)
```

```
$ python setup.py bdist_egg
```

egg

```
from setuptools import setup, find_packages
# To use a consistent encoding
from codecs import open
from os import path

here = path.abspath(path.dirname(__file__))

with open(path.join(here, 'README.rst'), encoding='utf-8') as f:
    long_description = f.read()

setup(
    name='metadatadata',
    version='1.0',
    description='MetrolinuxMetadata',
    long_description=long_description,
    url='http://metrolinux.com',
    author='sreeram',
    author_email='sreeram@metrolinux.com',
    license='Copyright',
    classifiers=[
        'Development Status :: 1 - Alpha',
        # Indicate who your project is intended for
        'Intended Audience :: Developers',
        'Topic :: Software Development :: Build Tools',
    ],
    packages=find_packages(exclude=['contrib', 'docs', 'tests']),
    extras_require={
        'dev': ['check-manifest'],
        'test': ['coverage'],
    },
    package_data={
        'sample': ['package_data.dat'],
    },
    data_files=[('my_data', ['data/data_file'])],
    py_modules=["__main__"],
    entry_points={
        'console_scripts': [
            'sample=sample:main',
        ],
    },
)
```



Agenda

What and Why Scala

Hello world Scala

Class and Object

Conditionals and Expressions - if...else, for, map

Language Specifics and Syntax

traits

Enumerations

Value Classes

Case Classes

Functions and Function Literals

Transformations, Filtering, Informational methods

File Operations

XML Manipulations

Concurrency

SBT

Best Practices

The Scala Language

Scala is a programming language which fuses object orientation and functional programming in a statically typed model.

Scala

Paradigm - A paradigm describes distinct concepts or thought patterns in a scientific discipline process. Scala way of programming is a paradigm.

Imperative Programming

- modifying mutable variable.
- using assignments.
- One tends to conceptualize data structure word by word.
- The style changes the program's state.

eg: Java

Scala

Paradigm - A paradigm describes distinct concepts or thought patterns in a scientific discipline process. Scala way of programming is a paradigm.

Functional Programming

- A programming style that models computation as a evaluation of expression
- avoid mutations
- express operators as functions
- powerful ways to abstract and compose functions. Programming without mutable variables, without assignments, without loops and without control structures. eg: Scala

Functional programming languages: Lisp, Scala, Haskell, Smalltalk, Ruby, Ocaml etc., First functional language was Lisp.

Expression vs Statement

Expression

```
val tellMe = if (100 > 98) true else false
```

An expression doesn't modify the original state of the object. Favors immutability.

Statement

```
boolean tellMe = false;
```

```
if (100 > 98)
    tellMe = true;
else
    tellMe = false;
```

```
System.out.println(tellMe);
```

A statement tends to modify the original object. Favours mutability.

The Scala Language

Scala gets its name from **Scalable Language**

Scala addresses the major needs of java developers
as it runs on a JVM

Scala has a light weight, concise syntax code.

The Scala Language

As the saying goes,

Java is slower, but JVM is faster.

That's the reason, the JVM based languages are becoming popular.

The Scala Language - Advantages

- [*] Scala is a pure object oriented language. No primitive types.
- [*] When compared to java, scala is less verbose.
- [*] Very concise and expressive. Of course less verbose.
- [*] In the long run, increased productivity.
- [*] Philosophically, humanity tends to evolve.

Scala

Scala uses substitution model. The substitution model is formalized in lambda calculus.

It is a good functional programming practice to split up a task into many small function.

\$ sbt console. Will also start a scala REPL.

The Scala Language

Designed by Martin Odersky

Started at around 2001 in switzerland and now a full fledged language running on JVM.

With the Apache Spark using scala, it has become popular in the big data world.



Scala Language Specifics

Scala does not require semicolons at the end of statements. They are allowed but optional. When you write in two or more statements in the same line, then you need to put in the semicolon.

Scala has Unit, while java has void.

Scala uses the *id: type* syntax whereas java uses *type id*.

Scala Language Specifics

Embraces both object-oriented as well as functional paradigm.

Scala allows java and code to be mixed since they both run on JVM.

Hello World Scala Program

HelloWorld.scala

```
package com.dmac

object HelloWorld {

    def main(args: Array[String]) {
        println("The world is good")
    }
}
```

An object definition defines a class with single instance.

Refer [HelloWorld.scala](#)

Scala Language Specifics - How to write in a method

Scala uses the *id: type* syntax whereas java uses *type id*.

```
/**  
 * A Simple Scala Method  
 */  
def scalaMethod(empName:String, empDepartment : String) : Int = {  
    return 1001  
}  
  
/* A Simple Java Method */
```

```
public Integer scalaMethod(String empName, String empDepartment) {  
    Integer i = new Integer(100);  
    return i;  
}
```

Refer DefiningAMethod.scala

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Extend the App class to make your class executable

```
object AppMain extends App {  
    println("The whole block of code is executed  
    when the Object class is extended from the  
    App")  
}
```

Refer AppMain.scala

var, val and def

def	defines a method
val	defines a fixed value which cannot be changed. Meaning, the variable is immutable.
var	defines a variable that can be modified. Meaning, the variable is mutable.

Data Types - Variable Definition

```
val simpleNumeric      = 1982
```

```
val simpleNumericaAlias = 1982 : Int
```

```
val simpleFloat       = 32f
```

```
val simpleFloatAlias = 32f : Float
```

```
val simpleDouble      = 33d
```

```
val simpleDoubleAlias = 33d : Double
```

```
val simpleLong        = 48787L
```

```
val simpleLongAlias  = 48787L : Long
```

Data Types - Variable Definition

All the four are legal and same

```
val contrats = 100
```

```
val contrats_1 = 200 : Int
```

```
val contracts_2 : Int = 300
```

```
val contrats_3 = { 100 }
```

Datatypes - Variable Definition

Both are legal definition

```
val myDataRefNumber = 10034560
```

```
val myDataRefNumberAliter = { 10023456 }
```

Datatypes

```
var addition = simpleNumeric + simpleNumeric
```

```
addition = simpleNumeric + 1
```

```
addition += 1
```

```
var titanicNumber = BigInt(1234567890)
```

```
var titanicDecimal = BigDecimal(63746.64636)
```

Datatypes

The `_` (underscore) initializes the variables with the default value.

```
var stringDefault : String = _  
var integerDefault : Int    = _  
var floatDefault : Float   = _  
var doubleDefault : Double = _
```

Note: All should be `var`. Default initializing won't hold good for `val` variables.

RememberingThe_Operator.scala

Datatypes

```
// In single quotes  
val character_literal = 'B'  
  
// In double quotes  
val string_datatype = "B"
```

Datatypes - Multiple Assignments

```
// Multiple Assignments
val (name: String, age: Int, salary : Float) = ("Chola", 100, 102f)

println(name)
println(age)
println(salary)
```

Scala allows multiple assignments on the single line.

DataTypes.scala

Syntax Rules

Arrays are written as `Array[T]` rather than `T[]`
`Array[String]` rather than `String[]`

Array selections are written as `a(i)` rather
than `a[i]`.

Scala REPL

Scala provides a REPL for ease of development.

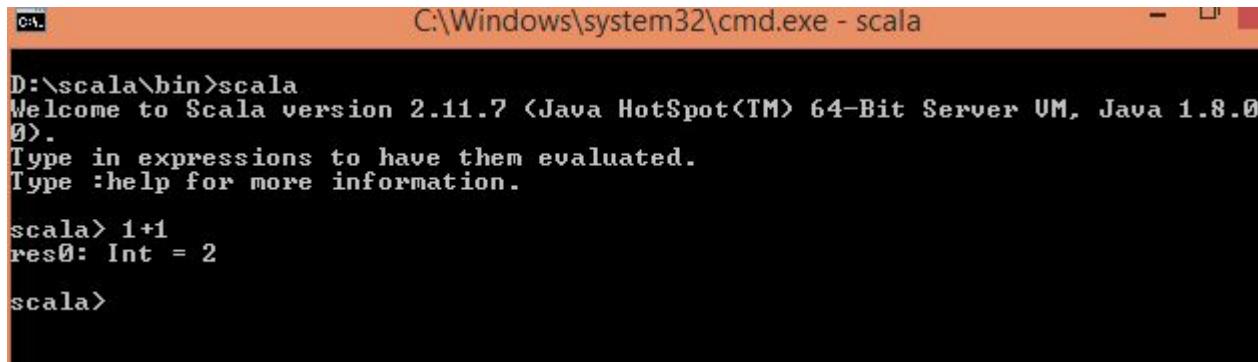
REPL => Read - Eval - Print - Loop

REPL helps in Experiment Driven Development
(EDD)

Scala REPL

To invoke scala REPL type in scala command inside the bin folder of the scala.

/scala_installation/bin/scala



A screenshot of a Windows Command Prompt window titled "C:\Windows\system32\cmd.exe - scala". The window shows the Scala REPL running. The output is as follows:

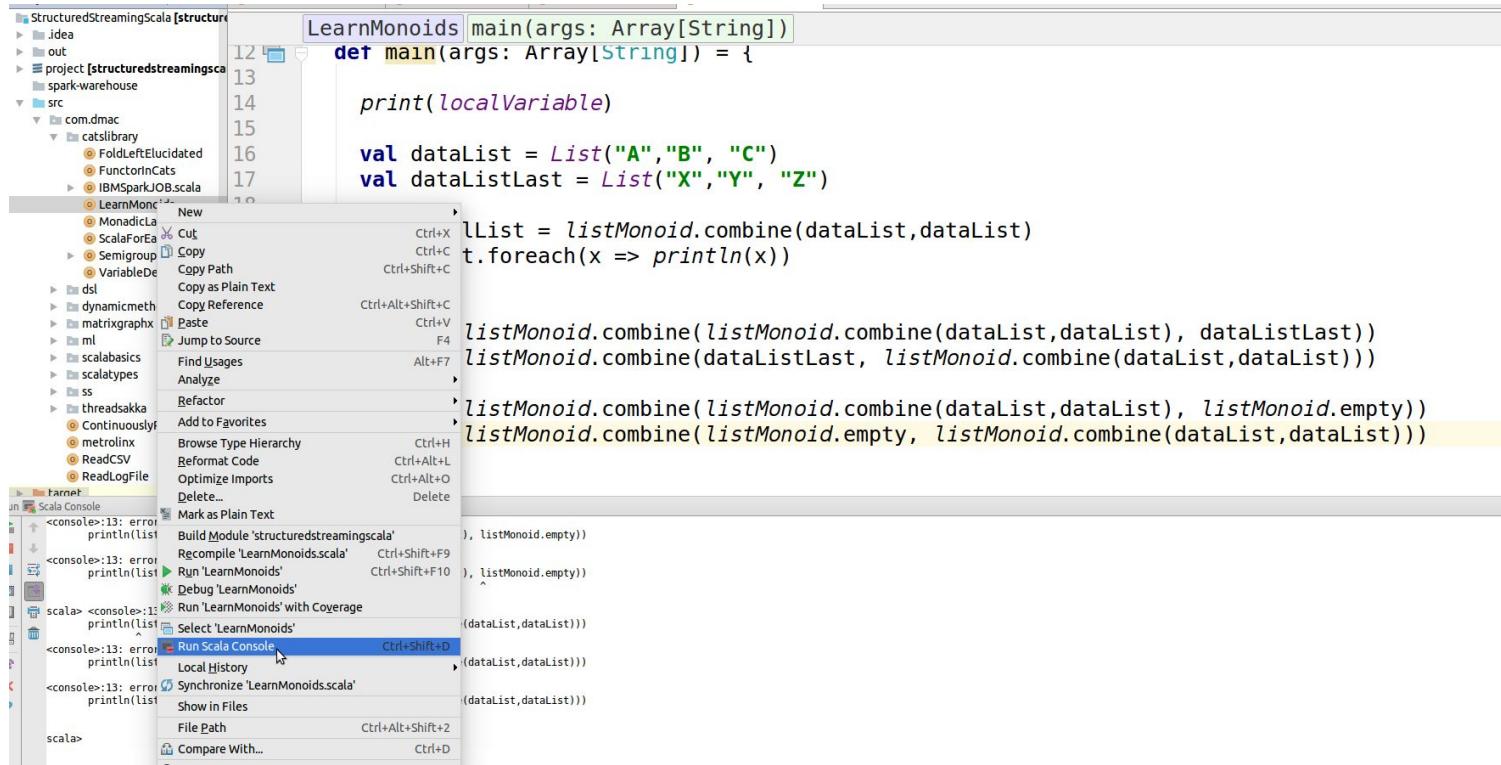
```
D:\scala\bin>scala
Welcome to Scala version 2.11.7 (Java HotSpot(TM) 64-Bit Server VM, Java 1.8.0_0).
Type in expressions to have them evaluated.
Type :help for more information.

scala> 1+1
res0: Int = 2

scala>
```

Scala REPL in IntelliJ

To run the scala REPL in the intellij, right click on the object file and click “Run Scala Console”.



scalac and scala

```
/scala_installation/bin/scalac AppMain.scala
```

```
/scala_installation/bin/scala com.dmac.basic.AppMain
```

Fast Scala Compiler (fsc)

```
/scala_installation/bin/fsc AppMain.scala
```

fsc uses a compilation daemon and a cache, so compiling repeatedly the same code base becomes much faster after the first dry run.

Packages

Organize your code as a set of packages.

Packages are usually the reverse hierarchy of your domain names. The usual way that we do in java based projects.

Class and Package Names

Class name need not be same as the source file name

Package name need not be coherent with the naming convention

Source file can have more than one public classes



The screenshot shows the Eclipse IDE interface with the Package Explorer and Editor panes. The Package Explorer pane on the left displays a project structure under 'ScalaTraining' with a 'src' folder containing various Scala files. The Editor pane on the right shows the content of the file 'ClassNameNeedNotBeSame.scala'. The code is annotated with orange boxes highlighting specific features:

```
ClassNameNeedNotBeSame.scala
package any.package.name

class ADifferentClassNameOtherThanASourceFile

class AClassCanHaveMultiplePublicClasses
```

The 'any.package.name' package declaration is highlighted with a blue box. The class names 'ADifferentClassNameOtherThanASourceFile' and 'AClassCanHaveMultiplePublicClasses' are both highlighted with orange boxes.

ClassNameNeedNotBeSame.scala

chinnasamyad@gmail.com

import statements

```
/* Importing multiple classes */  
import org.apache.spark.{SparkContext, SparkConf}
```

```
/* Importing all the classes */  
/* The _ can be compared as * operator on Java */  
import org.apache.spark._
```

```
/* Renaming a class at the time of import is allowed */  
import javax.swing.{ JFrame => MyAppFrame }
```

```
val myFrame = new MyAppFrame  
myFrame.show(true)
```

```
import javax.swing.JPanel  
val panel = new JPanel  
myFrame.add(panel)
```

Source: Basics.scala

chinnasamyad@gmail.com

import statements

```
/*
  Importing statements inside the function block is permitted.
  This type of import is valid within that block.

*/
def main(args : Array[String]) {
    import javax.swing.JPanel
    val panel = new JPanel

    myFrame.add(panel)

}
```

Source: Basics.scala

Invoking methods

```
def main(args : Array[String]) {  
  
    import javax.swing.JPanel  
    val panel = new JPanel  
  
    myFrame.add(panel)  
  
}  
myFrame add panel
```

Instead of invoking the add with a .
it can be invoked using by

Invoking methods

```
class MethodClass {  
  
    /**  
     * A Simple Function  
     */  
    def methodName(variableName : String) = {  
        println("Inside the methodName method - " + variableName)  
    }  
  
}
```

// An object is created using the new keyword
val methodClass = new MethodClass

// All the below three are legal when calling a scala method

methodClass.methodName("SOME_STRING")

methodClass methodName "SOME_STRING"

methodClass methodName {
 "SOME_STRING"
}

Refer ScalaMethods.scala

return statement

return keyword is not mandatory.

The last line of the statement in the block is considered the return value.

The value of the last executed statement or expression is the return value.

The first Simple Transformation map() and foreach()...

```
val list = List("Chinnasamy", "BigData")
```

```
list.map(x => x.toUpperCase)  
.foreach(each => println(each))
```

```
// This is also legal  
list.map({x => x.toUpperCase})  
.foreach(each => println(each))
```

```
// This is also legal  
list.map { x => x.toUpperCase }  
.foreach(each => println(each))
```

```
// This is also legal  
list.map(_.toUpperCase)  
.foreach(println(_))
```

If we don't use the lambda expression, then one has to write overridden boiler plate code.

```
val meshList = List ("Data0", "Data2", "Timeline0")
```

```
meshList.foreach(new Function[String, Unit] {  
  override def apply(v1: String): Unit = {  
    println(v1)  
  }  
})
```

```
meshList.map(new Function[String, String] {  
  override def apply(v1: String): String = {  
    v1.toLowerCase  
  }  
}).foreach(x => println(x))
```

Refer FlatMapExp.scala

Declarations and Type Inference

```
var declarationOfString = "I am a String Declared"  
  
var anotherVersionOfDeclarationOfString : String = "Another String Declared"  
  
println(declarationOfString); //Semicolon is not mandatory  
  
println(anotherVersionOfDeclarationOfString)  
  
val twelve = 3 + 9  
val assignMe = "Assign Me"
```

Scala language deducts the type automatically.
This phenomenon is called by the name **Type Inference**.

Scala has a built in type-inference mechanism. The compiler deduces the type from the initialization expression of the variable.

String Declarations

Scala strings are nothing but java strings,
so all java string methods are applicable on scala strings.

Functional methods can be invoked in
Strings

```
val aString = "CHE-GUERA"  
println(aString.drop(4)) // will print GUERA
```

```
val CONSTANT_STRING = "STRING"  
CONSTANT_STRING.drop(2).foreach { x => println(x) }
```

asInstanceOf

Instead of the casting use asInstanceOf.
- Child c = (Child) parent -

```
val instance = new InstanceOF  
instance passInRef(new Child)
```

```
class InstanceOF {  
  
  def passInRef(parent : Parent) {  
  
    val child = parent.asInstanceOf[Child]  
    println(child.childName)  
  
  }  
}
```

Call by name, Call by value

A call-by-name passes a code block to the call and each time the call access the parameter, the code block is executed and the value is calculated.

Parameters to functions are by-value parameters.

If we write a function that accepts a expression as a parameter, we do not want it to be evaluated till it is invoked in our function.

Call by name, Call by value

```
def returnMeSchema(): String = {
  println("Computing Schema...");
  "MYSQL"
}
```

```
def callByValue(input: String): Unit = {
  println("First Time print = " + input)
  println("Second Time print = " + input)
}
```

```
def callByName(input: => String): Unit = {
  println("First Time print = " + input)
  println("Second Time print = " + input)
}
```

```
/*
 * Computing Schema...
 * First Time print = MYSQL
 * Computing Schema...
 * Second Time print = MYSQL
 */
callByName(returnMeSchema)
```

```
/**
 * Computing Schema...
 * First Time print = MYSQL
 * Second Time print = MYSQL
 */
callByName(returnMeSchema)
```

Scala Data types

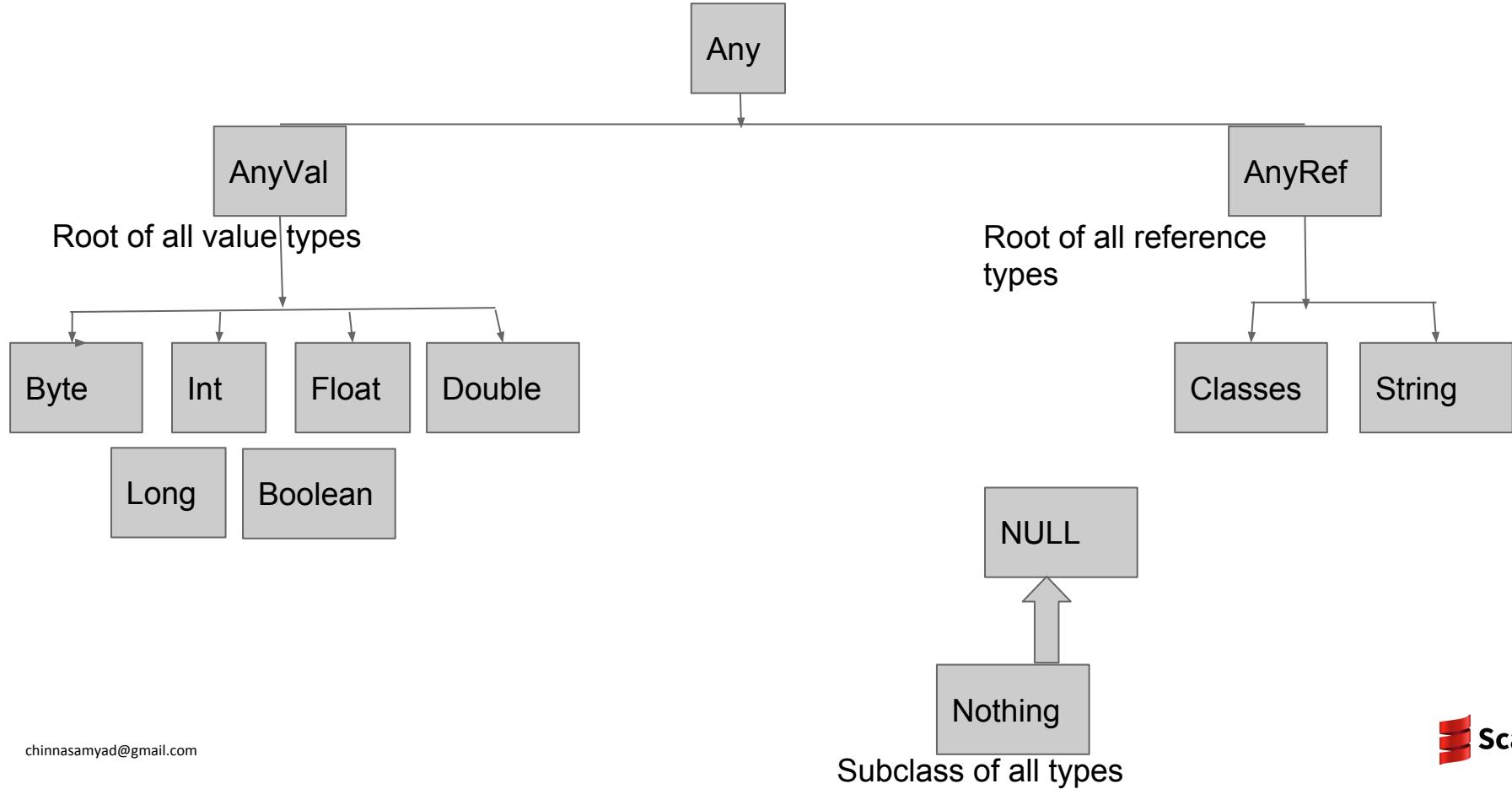
Byte
Short
Int
Long
Float
Double
Char
String
Boolean
Unit
Null
Nothing
Any
AnyRef

- No value (Equivalent to void in java)

- The subtype of every type. Includes no values

All are objects. There are no primitives as that of Java.

Scala Data types



A single source file can contain many packages

```
package parentpackage {  
    class PublicClass {  
        }  
        import com.dmac.basic.parentpackage.PublicClass  
        import com.dmac.basic.parentpackage.ChildClass  
        import com.dmac.basic.childPackage.ChildClass  
  
        package childPackage {  
            class ChildClass extends PublicClass {  
                def printer () {  
                    }  
            }  
        }  
}
```

Expressions and Conditionals

Expressions and Conditionals

def

var and val expressions

if...else

for

do...while

match

try...catch...finally

for...loop expression

```
// Simple loop //
```

```
for (i <- 1 to 10)  
    println(i)
```

Syntax

```
for (<identifier> <- <iterator> if (<boolean_expression>) )  
{
```

```
// Nested Loop //
```

```
for { i <- 1 to 10  
      j <- 1 to 10 }
```

```
}
```

```
    println(i, j)
```

Refer to [ConditionsAndExpressions.scala](#)

for...loop expression

```
println("\n\n\n Reverse Printing")
```

```
for (i <- 50 to 1 by -1)  
    println(i)
```

Prints from 50 decrementing by 1

Syntax

```
for (<identifier> <- <iterator> if (<boolean_expression>) )  
{  
}  
}
```

Refer to [ConditionsAndExpressions.scala](#)

for...loop expression

A generic **for** implementation

```
val meshList = List("Contract_1", "Contract_2", "Contract_3")  
  
for (each <- meshList)  
  println(each)
```

A for loop with a condition

```
val meshList = List("Contract_1", "Contract_2", "Contract_3")  
  
for (each <- meshList if (each.endsWith("_1")))  
  println(each)
```

for...loop expression

For Loop with Boolean Expression

```
val authProperties = List (  
    "AUA",  
    "ASA-Service Agency",  
    "TID",  
    "Version",  
    "UID",  
    "TXN",  
    "Encrypted-SKEY",  
    "Encrypted-SKEY-CertificateIdentifier",  
    "Data-Type",  
    "Data-Content-Encrypted-PID-XML",  
    "Encrypted-SKEY")
```

```
for (authElement <- authProperties if (authElement.startsWith("Data")))  
  println(authElement)
```

Refer to [ConditionsAndExpressions.scala](#)

break statement

```
import scala.util.control.Breaks  
  
val loop = new Breaks  
  
println("\n\n\n Reverse Printing")  
  
loop.breakable {  
    for (i <- 50 to 1 by -1) {  
        println(i)  
  
        if (i==40)  
            loop.break  
    }  
}
```

Refer to [ConditionsAndExpressions.scala](#)

do...while expression

```
var count = 0
```

```
do {  
    count += 1  
    println("My count = " + count)  
}  
while(count < 10)
```

Refer to [ConditionsAndExpressions.scala](#)

yield

Creates a new data structure and returns as a val.

Yield acts as a buffer and each iteration, the variable gets appended by the item based on the code after yield.

```
val vectorList = Vector(1,2,3,4,5)
```

```
val vectorReturn = for (element <- vectorList) yield element*2
```

Output : Vector(2, 4, 6, 8, 10)

Refer to [ConditionsAndExpressions.scala](#)

yield

The use of yield with the conditional if is shown below

```
val vectorList = Vector(1,2,3,4,5)
```

```
val evenNumberMultiplier = for (element <- vectorList if (element % 2 == 0))
                                yield element*2
```

Output : Vector(4, 8)

Refer to [ConditionsAndExpressions.scala](#)

if...else expression

```
if (<boolean_expression>)
    <code>
else  <code>
```

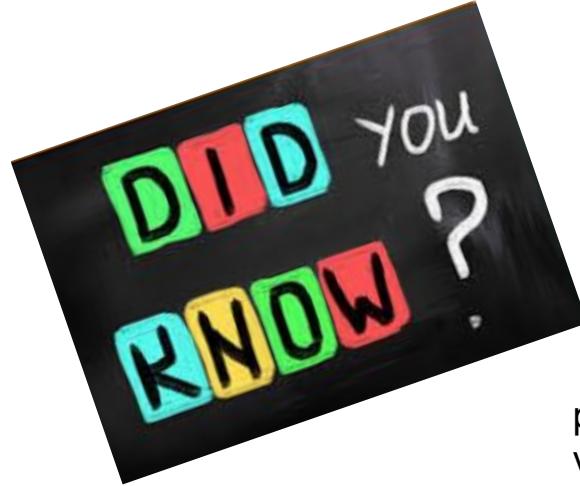
```
val x = if (a) y else z
```

Refer to [ConditionsAndExpressions.scala](#)

match

```
val month = input match {  
    case 1 => "JAN"  
    case 2 => "FEB"  
    case 3 => "MAR"  
    case 4 => "APR"  
    case 5 => "MAY"  
    case 6 => "JUNE"  
    case 7 => "JULY"  
    case 8 => "AUG"  
    case 9 => "SEP"  
    case 10 => "OCT"  
    case 11 => "NOV"  
    case 12 => "DEC"  
  
    case 0 | 13 => "Give an integer between 1 and 12"  
    case _ => "INVALID_MONTH"  
}
```

Refer to [Matcher.scala](#)



```
print("Enter a month : ")
val input = StdIn.readInt // Read the Input from the console
```

In comparison to the Scanner class of Java.

Refer to [Matcher.scala](#)

try...catch...finally

```
try {  
  
    val file = new FileReader("");  
    file.close()  
  
}  
catch {  
    case exception: FileNotFoundException => {  
        println("Hey Chin - File is not found")  
    }  
}  
finally {  
    println("Executing Finally")  
}
```

try...catch...finally

```
try {  
    val f = new FileReader("input.txt")  
  
}  
catch {  
    case ex: FileNotFoundException => {  
        println("File Not Found " + ex.getMessage)  
    }  
    case ex: IOException => {  
        println("IO Exception " + ex.getMessage)  
    }  
}  
finally {  
    println("Executing in finally")  
}  
  
def methodThrowsAException() = {  
    //val f = new FileReader("input.txt")  
    throw new IllegalStateException("Illegal Argument")  
}
```

try...catch...finally

```
try {  
    val f = new FileReader("input.txt")  
  
}  
catch {  
    case ex: FileNotFoundException => {  
        println("File Not Found " + ex.getMessage)  
    }  
    case ex: IOException => {  
        println("IO Exception " + ex.getMessage)  
    }  
}  
finally {  
    println("Executing in finally")  
}  
  
def methodThrowsAException() = {  
    //val f = new FileReader("input.txt")  
    throw new IllegalStateException("Illegal Argument")  
}
```

Try...catch...finally

```
val eh = new ExceptionHandler

try {
  eh.methodThrowsAException
}

catch {
  case ex: FileNotFoundException => { println("File Not Found " + ex.getMessage) }
  case ex: IOException      => { println("IO Exception " + ex.getMessage) }
  case ex: IllegalStateException => { println("Message - " + ex.getMessage) }
}
```

ExceptionHandling.scala

String Interpolation

Scala offers a very elegant way to represent strings. The representation is called by the name string interpolation.

```
val goldRate = 2400.34  
println(f"Todos gold rate = $goldRate")
```

```
val exceptionMessage = "SLZ Zone Runtime Exception occurred"  
println(s"Exception message is : $exceptionMessage")
```

In java, you can achieve this using String.format method.

Interpolation.scala

Classes

Classes are the core building block of object-oriented languages.

A combination of data structures and functions.

The noun names of the problem statement is chosen as the class name.

class and object

An object has only one instance. A class can have multiple instances.

A component of type object is a singleton object.

```
class ReadCSVFile {  
  
    def readCSVFile(csvFileName : String) : Unit = {  
        // reading the CSV File Logic  
    }  
}  
object SparkReadFile {  
  
    def main(args : Array[String]) : Unit = {  
        println("SparkReadFile")  
    }  
}
```

ReadCSVFile is a class which can have constructors a typical class

SparkReadFile is a single instance and cannot have constructors but can extend other classes

companion object and a companion class

// Companion class of the object

```
class FactoryMethod {  
  
    def executeSomeComplexBusinessLogic : String = {  
        println("Execute Inside Factory Method")  
        "executed_success"  
    }  
}
```

// Companion Object of the class FactoryMethod

```
object FactoryMethod {  
  
    def execute() : String = {  
        val fm = new FactoryMethod  
        fm.executeSomeComplexBusinessLogic  
    }  
}
```

A companion object shares the same name as that of the class.

You will find this pattern to be used inside the scala source code.

CompanionObject.scala

Class, subclass, abstract class, traits

Use the **extends** keyword to extend a class.

And use the **override** keyword to override a super class method.

Use abstract class when a constructor is to be given or else you can use a trait.

When extending third party traits, use an abstract class to extend traits.

Classes

```
class CSVLogReader extends LogReader {  
  
    override def readFileName() : String = {  
        //CSV_FILE"  
        super.readFileName()  
    }  
}  
  
class LogReader {  
  
    def readFileName() : String = {  
        val fileName = "SIMPLE_FILE_1"; fileName  
    }  
}
```

Refer to ScalaClass.scala in the code

Instantiating a class

```
val csvReader = new CSVLogReader  
  
val csvReader = new CSVLogReader()  
  
val csvReader = new CSVLogReader();  
  
val csvReader = new CSVLogReader;  
  
    println(csvReader.readFileName())
```

Class and traits

Traits define the object types by specifying the signature of the method.
(In comparable to Java interfaces)

Scala allows traits to have partial implementations.

In java, classes implements interfaces, whereas in scala a class extends a trait.

Use the override keyword to override the concrete implemented method in trait.

Class

Write down the problem statement. Underline the nouns. The nouns form the name of the class.

The following words are the prefix/suffix for declaring a class name:

Coordinator, Builder, Writer

Reader, Handler, Container

Protocol, Target, Converter

Controller, View, Factory

Entity, Bucket, Reckoner

Elucidator

Noun is a name of a person, animal or a thing.

Class and traits

```
class VoldemortKeyValueStore extends KeyValueStoreTrait {  
  
    def get() : String = {  
        return ""  
    }  
  
    def put(value : Any) : Boolean = {  
  
        val recordInserted = true  
  
        return recordInserted  
    }  
  
    override def dataStoreName(): String = {  
        return "VOLDEMORT"  
    }  
  
    trait KeyValueStoreTrait {  
  
        def put(value : Any) : Boolean  
  
        def get() : Any  
  
        def dataStoreName(): String = {  
            return "REDIS"  
        }  
    }  
}
```

Traits can extend other traits

```
trait ZeusTrait {  
    def zeusMethod  
}
```

```
trait SupremeTrait {  
    def supremeMethod  
}
```

```
trait SuperTrait {  
    def superMethod() : String = {  
        "SUPER_TRAIT"  
    }  
}
```

```
trait MyTrait extends SuperTrait  
    with SupremeTrait with ZeusTrait {  
}
```

Note: A class can extend only one class but can use the **with** keyword to mixin with multiple traits.

Traits can be implemented by anonymizing

```
trait Debugger {  
    def printTrace(input : String) = {  
        println(s"Tracing ... : $input")  
    }  
}  
  
trait MachineLearning {  
  
    var algorithmMarkedByUser = ""  
  
    def regression(input : String) {  
        println("Implementing Regression")  
    }  
  
    def supportVectorMachine(input : String)  
    def clustering(input: String) = {  
        println("Implementing Clustering")  
    }  
}  
  
// A trait can be instantiated in a anonymous way  
val debugger = new Debugger {  
}  
  
debugger printTrace "debugger trait anonimized"  
  
// A trait can be instantiated in a anonymous way.  
// But abstract methods has to be implemented.  
val machineLearning = new MachineLearning {  
    override def supportVectorMachine(input: String) = {  
    }  
}
```

Class constructor

```
// Primary Constructor  
class HighClass(name : String, id: Int) {  
  
    // Auxillary Constructor  
    def this(name: String) {  
        this(name, 88)  
    }  
  
    def this() {  
        this("_NO_ARG_")  
    }  
}
```

```
// Invoking Primary Constructor  
val hc = new HighClass("HIGH_CLASS", 100)
```

```
//Invoking Auxillary Constructor  
val clazz = new HighClass("ONE_ARG")
```

```
//Invoking Auxillary Constructor  
val hClass = new HighClass
```

Class constructor

Class constructor containing var and val parameters.

```
class HighClass(val name : String, var id: Int) {  
  
    def this(name: String) {  
        this(name, 88)  
    }  
  
    def this() {  
        this("_NO_ARG_")  
    }  
}
```

```
val hc = new HighClass("HIGH_CLASS", 100)
```

```
//hc.name = "HC" // Cannot assign to val  
hc.id = 999
```

Members defined as val cannot be assigned a new value.

Members defined as var can be reassigned.

Object class constructor

The object class can have constructor using the companion object.

```
class ObjectClass {  
  
    private var objectName = ""  
    val oc = ObjectClass("Richard_Stallman")  
  
    def getNameOfObject() : String = {  
        objectName  
    }  
}  
  
object ObjectClass {  
  
    def apply(name : String) : ObjectClass = {  
        var objectClass = new ObjectClass  
        objectClass.objectName = name  
        objectClass  
    }  
}
```

Object class constructor

The object class can have constructor using the companion object.

```
object DataStructure {  
  
    def apply(name: String): DataStructure = {  
        var ds = new DataStructure  
        ds.set(name)  
        ds  
    }  
}  
  
class DataStructure() {  
  
    var _name = ""  
  
    def get(): String = {  
        _name  
    }  
  
    def set(name : String) {  
        _name = name  
    }  
}
```

val ds = DataStructure("HASHMAP")
println(ds.get())

Mixin

Mixin is the process by which a trait is mixed with a class to form a robust design.

A mixin is achieved by using the **extends** and **with** keyword.

trait as mixins

```
class OpenSSO extends Authentication {  
  
    def login(userName : String, password : String) = {  
        true  
    }  
  
    def logout(userName: String) = {  
        true  
    }  
  
    def checkForLogin() = {  
        println("login check using opensso library")  
    }  
  
    override def protocol = {  
        "OPEN_SSO"  
    }  
}
```

```
trait Authentication {  
  
    def login(userName : String, password : String) : Boolean  
  
    def logout(userName: String) : Boolean  
  
    def checkForLogin()  
  
    def protocol = {  
        "_NO_PROTOCOL_IMPLEMENTED_"  
    }  
}  
  
class OpenLDAP extends Authentication {  
  
    def login(userName : String, password : String) = {  
        true  
    }  
  
    def logout(userName: String) = { true }  
  
    def checkForLogin() = { println("login check using ldap library") }  
  
    override def protocol = {  
        "OPEN_LDAP" }  
}
```

trait as mixins

```
trait AuthenticatioHBASELoggingTrait {  
  
    def logIntoElasticSearch(userName : String) = {  
        println("Logging into HBASE")  
    }  
}  
  
trait NotifyThirdPartyTrait {  
  
    def notify(userName : String) = {  
        println(s"Notifying that $userName has logged in")  
    }  
}
```

```
class OpenSSOClient extends OpenSSO  
    with AuthenticatioHBASELoggingTrait  
    with NotifyThirdPartyTrait {  
    }  
}
```

When to use abstract class

```
trait DatabaseOperationTrait { // (name : String) {  
    def save  
    def update  
    def delete  
}  
  
abstract class AbstractDatabaseOperation(name:String) {  
  
}  
  
class MySQL(dataBaseName:String) extends  
    AbstractDatabaseOperation(dataBaseName) {  
  
}
```

*Use abstract class when you want to pass in
a constructor*

*Use it judiciously when interacting with third
party trait libraries*

*A trait cannot have a constructor, while an abstract class can have a
constructor.*

traits with object classes

```
object TraitRules extends App {  
  
    val ocean = new OceanApp with Debugger  
    ocean.printTrace("Tracing an error")  
  
}
```

```
class OceanApp {  
  
}  
  
trait Debugger {  
    def printTrace(input : String) = {  
        println(s"Tracing ... : $input")  
    }  
  
}
```

TraitRules.scala

Compound Types

```
object CompoundTypesInScala {  
  
  def main(args : Array[String]) = {  
    computeData(new DataReaderImpl())  
  }  
  
  // Compound types in Scala  
  def computeData(data : CSVDataReader with XMLDataReader with AbstractReader) = {  
  }  
}
```

In compound types, `computeData()` is the compound type scala definition that contains what type of type implementation is expected.

```
trait CSVDataReader {  
  
  def readCSVData() = {  
  }  
}  
  
trait XMLDataReader {  
  
  def readXMLData() = {  
  }  
}  
  
trait AbstractReader {  
}  
  
class DataReaderImpl extends CSVDataReader with XMLDataReader with AbstractReader {  
}
```

sealed classes

The sealed keyword enforces that all subclasses must be declared in the same source file.

SealedClasses.scala

```
sealed class FileFactory {
```

```
}
```

```
class XMLFileFactory extends FileFactory {
```

```
}
```

Usage: The Option class in the scala library is a sealed class.
sealed abstract class Option.

enumeration

An enumeration is defined by extending the Enumeration class of scala.

```
object CountryCode extends Enumeration {  
    type CountryCode = Value  
  
    val INDIA = Value("IN")  
    val FRANCE = Value("FR")  
    val RUSSIA = Value("RU")  
}
```

Invoking an enumeration

```
for ( country <- CountryCode.values)  
    println(s"$country" + " " + country.id)  
  
println(CountryCode.FRANCE)
```

Lazy Evaluation

A variable defined `lazy` is evaluated only when it is needed.

Lazy evaluation is used mainly on

- File based properties

- Opening a database collections

```
lazy val expensiveResource : Int = doExpensiveOperation

def doExpensiveOperation() : Int = {
    println("Doing Expensive Operation")
    999
}
```

Lazy Evaluation

```
class Lazzy {  
  
    var randomVar = { println("Random Var"); Random.nextInt}  
    val randomX = { println("Random X"); Random.nextInt}  
  
    lazy val randomY = { println("Random Y"); Random.nextInt()  
}
```

```
}
```

```
def main(args: Array[String]) {  
    val lazzy = new Lazzy  
  
    //println(lazzy.randomX)  
    //println(lazzy.randomVar)  
  
    //println(lazzy.randomY)  
}
```

Lazy Collection - Stream

Stream collection are lazy in nature.

```
def returnStream() : Stream[AnyRef] = {  
    val stream = Stream("Oracle", "DB2")  
  
    val numberStream = Stream(1,2,3)  
    numberStream.take(2).foreach { x => println(x) }  
  
    return stream  
}
```

Case classes

Case classes have the hashCode, equals, method to be created automatically.

By default, all property in a case class have val properties.

Case classes are mainly used as POJO's or DTO(Data Transfer Objects).

Case classes

```
case class DBProperties(var DataBaseName: String,  
                      var portNo : Int,  
                      var connectionString :String,  
                      var schemaName: String)
```

```
var dbProp = DBProperties("slz_core",3306,"jdbc:mysql:slz-zone3","slz_core")  
  
println(dbProp.connectionString)  
dbProp.connectionString = "jdbc:oracle:slz-zone2"  
  
println(dbProp.connectionString)
```

Case classes

Case classes can extend other case classes

Case class can also be final.

If the case class is made final, then it can't be extended.

Case class can also extend other normal classes.

Value classes

Value classes are the custom classes that extend the AnyVal

Value classes

Value classes are those which extend the AnyVal

```
val dollar = new Dollar(100)  
println(dollar)
```

```
class Dollar(val value: Float) extends AnyVal {  
    override def toString = value.toString  
}
```

Strings

Representing multi-line strings

```
val multiLineString = "First Line " +  
                      "Second Line"
```

```
val multiLineStringAlias = """ This is first Line  
                           This is second line  
                           This is third line """
```

Visibility Scopes

public

_no_keyword_

protected

protected

private

private

scoped protected

protected[scope]

scoped private

private[scope]

scope: class name, package name, this

Visibility Scopes

```
package parentpackage {  
  
    class PublicClass  
    {  
  
        private          val privateValue      = 22  
        protected       val protectedValue    = 33  
  
        private[parentpackage] val privatePackageScoped = 44  
        private[PublicClass]   val privateClassScoped  = 55  
        protected[PublicClass] val protectedClassScoped = 66  
    }  
  
    class ChildClass extends PublicClass {  
  
        def printer () {  
            println(this.protectedValue)  
            println(this.privatePackageScoped)  
            println(this.protectedClassScoped)  
        }  
    }  
}
```

Visibility Scopes

```
package childPackage {  
  
    class ChildClass extends PublicClass {  
        def printer () {  
            this.protectedValue  
            this.protectedClassScoped  
        }  
    }  
}
```

VisibilityScopes.scala

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Scala Collections

Scala Collections

Base classes

Iterable, Seq, Set, Map

Immutable Collections

List, Stream, Vector, Range, String, Map, Set

Mutable Collections

Arrays

Scala Collections

List

An immutable list

Stream

Same as list, but the tail is evaluated
on demand.

Set

Collection with unique elements

Map

Key/value pair DS.

Array

A mutable collection

Tuple

Encapsulated store

Range

Range of values containing integers

Vector

For fast access

List

Fundamental data structure.

Simple Immutable single linked list.

List are immutable in nature.

```
val aadhaarPktState = List("PKT_REJECTED",
                           "PKT_DUPLICATE",
                           "PKT BIOMETRIC_STAGE_ABIS")
```

```
println(aadhaarPktState(1))
```

```
for(i <- aadhaarPktState)
  println(i)
```

List can also be of varied data types.

```
val multiTypeList = List(500, "INTERNAL_SERVER_ERROR", true)
```

multiTypeList is of type List[Any]

List

To modify a list, convert it to Buffer, modify it and then convert back to list.

```
val countryCodeList = List("IN", "SL", "CA")
```

```
val buffer = countryCodeList.toBuffer
```

```
buffer += "NL"
```

```
print(buffer.toList)
```

List

The addString() method is completely a different one.
It's just a utility method.

```
val countryCodeList = List("IN", "SL", "CA")  
  
val output = new StringBuilder("The various countries are :")  
  
val newList = countryCodeList.addString(output, "[", ", ", "]")  
  
print(newList)
```

o/p:
The various countries are : [IN,SL,CA]

List

List can also be created using the :: (cons - construct) operator as shown below.

When using the cons operator, Nil has to be specified at the end of the list.

```
val errorCodes = "200_OK" :: "404_BAD_REQUEST" :: "500_INTERNAL_SERVER_ERROR"  
                  :: "520_UNKNOWN_ERROR" :: Nil  
  
errorCodes.foreach { errorCode => println(errorCode) }
```

CollectionClasses.scala

Sequence - Seq

Seq is an abstract of list. A list can be passed to a place where seq is expected.

A sequence can be defined as below.

```
val algoSeq = Seq(1,5,"regression", "svm","tensor")
algoSeq.foreach(each => println(each))
```

Array

Arrays can be accessed in two ways as shown below:

Arrays are mutable data structure.

[1]

```
val dataArray = new Array[String](3)
dataArray(0) = "CASSANDRA"
dataArray.foreach(each => println(each))
```

[2]

```
val noSQLArray = Array("Cassandra", "BigSQL", "REDIS", 100)
noSQLArray.foreach(each => println(each))
```

Set

Set is a immutable, unordered collection of unique elements.

```
val setOfNumbers = Set(1,1,2,2,3,3)  
setOfNumbers.foreach { x => println(x) }
```

Set - Mutable Set

```
{
```

```
import scala.collection.mutable.Set
println("\n\n\n Printing The Mutable Set")
val mutableSet = Set(1,2,2,3,3)
mutableSet.add(4)
mutableSet.foreach { x => println(x) }
```

```
}
```

Map

Map is a key-value pair.

Aka hashmap, associative arrays in other languages. Elements specified in the Map are represented as Tuples in Scala.

```
val cacheCleanerMap = Map(1 -> "AuaCacheCleaner",
                         2 -> "AsaCacheCleaner",
                         3 -> "ResidentDataCacheCleaner",
                         4 -> "LicenseCacheCleaner")
```

```
cacheCleanerMap.foreach(x => println(x._1 + x._2))
```

Map - Mutable Map

```
import scala.collection.mutable.Map

var cacheCleanerMutableMap = Map(1 -> "AuaCacheCleaner",
                                2 -> "AsaCacheCleaner",
                                3 -> "ResidentDataCacheCleaner",
                                4 -> "LicenseCacheCleaner")
cacheCleanerMutableMap += (5 -> "_END_")

cacheCleanerMutableMap foreach(x => println(x._1 + x._2))
```

Map - Mutable Map - getOrElseUpdate

```
val countryCode = collection.mutable.Map("IN" -> "India",  
                                         "FR" -> "France")
```

```
val retrieveCodeNotPresent = countryCode.get("US")
```

// Will update the original map

```
val retrieveCodePresent = countryCode.getOrElseUpdate("US", "UnitedStates")
```

// Will not update the original map

```
val retrieveCodePresent = countryCode.getOrElse("US", "UnitedStates")
```

```
val updatedCode = countryCode.get("US")
```

```
println(retrieveCodeNotPresent)  
println(retrieveCodePresent)  
println(updatedCode)
```

// Will return None
// Will return UnitedStates
// Will return UnitedStates

Mutable vs Immutable

Immutable Type

`collection.immutable.Set`

`collection.immutable.Map`

`collection.immutable.List`

Mutable Type

`collection.mutable.Set`

`collection.mutable.Map`

`collection.mutable.Buffer`

Mutable Stores

```
// Uses List (Linked List) Internally  
val listBufferStore = collection.mutable.ListBuffer(1,2,3)
```

```
override def productsFromUser(user: User): List[Product] = {  
    var listOfProducts = ListBuffer[Product]()  
    user.orders.map(eachOrder => {  
        eachOrder.items.foreach(  
            eachSeq => listOfProducts += eachSeq._1)  
    })  
    listOfProducts.toList  
}  
case class Product(name: String, price: Int, categoryName: Option[String])
```

1. A list buffer containing a custom DTO product

2. A list buffer adding in Product

3. A list buffer converted to a immutable list.

```
// Uses Arrays Internally  
val arrayBufferStore = collection.mutable.ArrayBuffer(1,2,3)
```

Arrays

Arrays are fixed size, mutable collection.
It's a wrapper over the Java array type.

Range

Range generates a sequence. The three operators for sequence are:

<i>to</i>	- <i>inclusive</i>
<i>until</i>	- <i>exclusive</i>
<i>by</i>	

```
var range100 = 1 to 100  
var range50 = 1 to 100 by 2
```

```
println(range100)
```

```
for (i <- range100)  
  println(i)
```

Range

```
// Will consider the elements from 1 to 20  
val range20 = 1 until 21
```

```
println(range20)
```

Output: Range(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20)

```
range20.foreach { element => println(element) }
```

```
for (element <- range20)  
  println(element)
```

Range - Character Ranges

```
val characterRange = 'a' to 'z'
```

```
println(characterRange)
```

```
NumericRange(a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q,  
r, s, t, u, v, w, x, y, z)
```

```
val characterRangeCaps = 'A' to 'Z'
```

```
println(characterRangeCaps)
```

```
NumericRange(A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q,  
R, S, T, U, V, W, X, Y, Z)
```

```
val characterRangeByTwo = 'a' to 'z' by 2
```

```
println(characterRangeByTwo)
```

```
NumericRange(a, c, e, g, i, k, m, o, q, s, u, w, y)
```

```
println(characterRange(1))
```

```
b
```

Tuple

An ordered collection of two or more values.

All values may be of same or different types.

Represented as :

```
val tupleStore = ("Insight into scala", 5, true)
```

Tuple

```
val tupleStore =  
(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,"17",18,19,20,21,22)
```

```
println(tupleStore._22) // Prints the 22 value in the tuple
```

```
val complexTuple = ("Insight into scala", 5, true)
```

Note: There can be a maximum of only 22 elements in a tuple

Tuple - Iterating a tuple

```
val auabaseCodes = ("PACK_CBE",
                    "PACK_BANG",
                    "PACK_CHE",
                    "PACK_RAN")
```

```
println(auabaseCodes.productElement(0))
```

```
for (i <- 0 to 3)
  println(auabaseCodes.productElement(i))
```

Vector

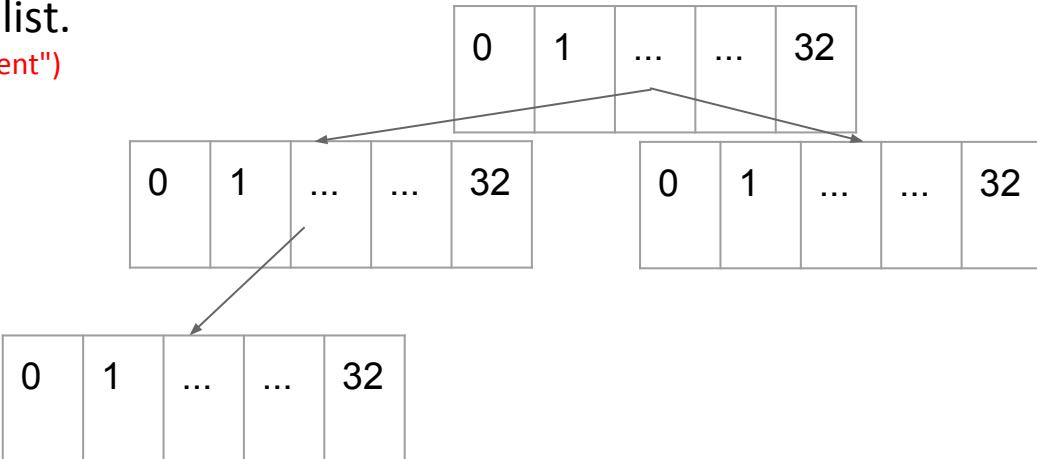
Vector initially with 32 elements is a simple array. i.e., with a branching factor of 32.

Vector has its creation analogy to the list.

```
val vectorStore = Vector(1, 2, 3, 4, "Last Element")
```

Vector forms a shallow tree

Vector is used for fast random access.



Vector

```
val vectorStore = Vector(1, 2, 3, 4, "Last Element")
val vectorStoreUpdated = 100 +: vectorStore :+ 999

vectorStoreUpdated.foreach { x => println(x) }
```

- +: Appends the element to the head of the dataset.
- :+ Appends the element to the end of the dataset.

Parallel Collections

Parallel data structure can be obtained from any collection using the par method.

```
val multiTypeList = List(500, "INTERNAL_SERVER_ERROR", true)
val parallelMultiTypeList = multiTypeList.par
```

It can also be constructed by following means.

```
import scala.collection.parallel.mutable.ParArray
import scala.collection.parallel.mutable.ParMap
```

```
val parallelArray = ParArray(1,2,3)
```

```
val parallelHashMap = ParMap("key" -> "value")
```

Parallel Collections

```
import scala.collection.parallel.mutable.ParArray  
import scala.collection.parallel.mutable.ParHashMap  
import scala.collection.parallel.mutable.ParMap  
import scala.collection.parallel.mutable.ParSet  
import scala.collection.parallel.mutable.ParSeq
```

```
import scala.collection.parallel.immutable.ParHashMap  
import scala.collection.parallel.immutable.ParHashSet  
import scala.collection.parallel.immutable.ParVector  
import scala.collection.parallel.immutable.ParMap  
import scala.collection.parallel.immutable.ParSet  
import scala.collection.parallel.immutable.ParSeq
```

Immutable to mutable

```
val cacheCleanerMap = Map(1 -> "AuaCacheCleaner",
                         2 -> "AsaCacheCleaner",
                         3 -> "ResidentDataCacheCleaner",
                         4 -> "LicenseCacheCleaner")
```

```
// Converting a Immutable Map to Mutable Buffer
var cacheCleanerBuffer = cacheCleanerMap.toBuffer
cacheCleanerBuffer += (5 -> "")
```

```
val immutableCacheCleanerMap = cacheCleanerBuffer.toMap
```

When to use

List

$O(1)$ for head element. But $O(n)$ for remaining elements.
If you want prepend, then use List.

Vector

$O(1)$ for almost all operations.
For random access, use Vector.

Array

Do not use for prepending elements.

Scala Function Combinators

map

foreach

filter

zip

partition

.... and many more.

Scala Functions

Functions are first class citizens in scala

Scala Method Declaration

```
def method_name(id : type) : return_type = {  
}  
  
def countNumberOfWords(fileContents : String) : Integer = {  
  
  val st = new StringTokenizer(fileContents)  
  return new Integer(st.countTokens())  
  
}
```

Procedures

A Procedure is a function that doesn't have a return value.

```
//A interpolated float and string values
def todaysGoldRate(goldRate: Double) = println(f"Todos Gold Rate $goldRate")

def logWarn(warningMessage : String) = println(s"Logging a warning message - $warningMessage")

todaysGoldRate(2390.78)
logWarn("OOM Error may occur")
```

Check out Procedure.scala example

Function with empty parentheses

```
// Function with empty parameters  
  
def fetchNoSQLStore() : String = "REDIS"
```

```
// Function with empty parameters with the brackets  
  
def fetchCache() : String = {  
    return "voldemort"  
}
```

Check out ScalaFunctions.scala

Function with named parameters

```
val clazz = new AScalaClass
```

```
// Calling a function with named parameter
```

```
clazz.fetchLicenseRecords(fetchStrategy = "eager", pageStart = 200, tableName =  
"LearningZoneOrganizations", pageEnd = 300)
```

Scala allows to call a method by using parameter names in the method call.
Which gives the flexibility of specifying orderless parameters.

```
/**  
 * A simple function  
 */  
def fetchLicenseRecords(tableName : String,  
                      pageStart : Int,  
                      pageEnd : Int,  
                      fetchStrategy: String) : Boolean = {  
  
    println("TableName - " + tableName)  
    println("Fetch Strategy - " + fetchStrategy)  
    println("Start - " + pageStart)  
    println("End - " + pageEnd)  
  
    return true  
}
```

Function with default values

```
clazz.retrieveEnvironmentProperties("araviuser")
clazz.retrieveEnvironmentProperties("chinuser", "QA")
```

```
def retrieveEnvironmentProperties(userName: String, environment : String =
"DEV") = {
    println("Environment - " + environment)
    println("UserName - " + userName)
}
```

Function names with symbols

```
val methodClass = new MethodClass

println(methodClass.++("ARAVINDH "))
println(methodClass ++ "ARAVINDH " )

/**
 * Methods names can be of symbols
 */
def ++ (input : String) : String = {
    input.concat(input)
}
```

ScalaMethods.scala

Function names with symbols

```
val methodClass = new MethodClass
```

```
println (methodClass +!@%%%%%%%%%&* "NAME")
```

```
def +!@%%%%%%%%%&* (input : String) : String = {  
  "COMPLEX_NAMING"  
}
```

Function names with symbols - Operator Overloading

Operator Overloading using the + operator

```
val ofContract = new Contracts("OF365","3-Days")
val bhiveContract = new Contracts("BHIVE","5-Days")
```

```
val addedContracts = ofContract + bhiveContract
addedContracts toString()
```

Contract - OF365 BHIVE Timeline = 3-Days 5-Days

Using the unary operator makes way for operator precedence

```
val notBHive = ! bhiveContract
notBHive toString()
```

Contract - EVIHB Timeline = syaD-5

```
class Contracts(val name : String, val timeLine : String) {

  def + (that:Contracts) : Contracts = {
    new Contracts(this.name + " " + that.name, this.timeLine + " " +
    that.timeLine)
  }

  override def toString: String = {
    println("Contract - " + this.name + " ,Timeline = " + this.timeLine)
    "None"
  }

  def unary_! : Contracts = {
    new Contracts(this.name.reverse, this.timeLine.reverse)
  }
}
```

Function with vararg parameters

```
/**  
 * Function as a variable argument parameter  
 */  
def saveAUA(aua : String*) : Unit = {  
    for (i <- aua)  
        println(i)  
}  
  
clazz.saveAUA("BANG_AUA", "CHENNAI_AUA", "COIM_AUA")
```

Function Literals

Function Literals are nothing but lambda expressions which came in to reduce the boiler plate code of what we use to write as Anonymous functions.

Function literals are derived from the lambda calculus syntax.

λ -calculus is a mathematical logic for expressing computation based on abstraction and application using variable binding and substitution. $x \rightarrow x * 2$ is the lambda calculus expression from which lambda calculus was inspired and developed.

Function Literals

```
{    variable_name  =>  << block_of_code >> }
```

```
val complexQueing = List("QUEUE",
    "TOPIC", "FANOUT", "_NO_QUEUE_");
```

```
complexQueing.foreach { name => println(name) }
```

Higher Order Functions

Functions that take other functions as parameters or that return function as results are called higher order function.

A function taking a function as a parameter or in other words the result of a function is another function.

To elucidate, it is a function that has a value with a function type as input parameter or a return value.

Very flexible way of composing programs.

Higher Order Functions

First order function is one that acts on list, int, string etc.., types.
But a higher order function is one that acts on function types.

Higher Order Functions

```
// Higher Order Function
def process(fn: (String,String) => String, x, y, z, .....)= {
  fn(actual_input, string_to_be_concatenated)
}
```

```
// Higher Order Function
def process(fn: (String,String) => String, actual_input:String, string_to_be_concatenated :String) = {
  fn(actual_input, string_to_be_concatenated)
}
```

Higher Order Functions

```
// Higher Order Function
def process(fn: (String, String) => String, actual_input: String, string_to_be_concatenated : String) = {
  fn(actual_input, string_to_be_concatenated)
}

val resultAfterPostfix = process(stringProcessor.postFixString, "Martin", "Odersky")
val resultAfterPrefix = process(stringProcessor.prefixString, "Martin", "Odersky")

// An anonymous function executing the same
val anonymousFunctionResult = process((x,y) => x.concat(y), "Martin", "Odersky")

// Using an _ and _
val resultAfterPostfix = process(_.concat(_), "Martin", "Odersky")
```

```
class StringProcessor {

  def prefixString(inputString : String, string_to_be_concatenated: String) : String = {
    string_to_be_concatenated.concat(" " + inputString)
  }

  def postFixString(inputString : String, string_to_be_concatenated: String) : String = {
    inputString.concat(" " + string_to_be_concatenated)
  }
}
```

Anonymous Functions

// Higher Order Function

```
def process(fn: (String, String) => String, actual_input: String, string_to_be_concatenated : String) = {  
    fn(actual_input, string_to_be_concatenated)  
}
```

// An anonymous function executing the same

```
val anonymousFunctionResult = process((x,y) => x.concat(y), "Martin", "Odersky")
```

```
class StringProcessor {
```

```
    def prefixString(inputString : String, string_to_be_concatenated: String) : String = {  
        string_to_be_concatenated.concat("_" + inputString)  
    }
```

```
    def postFixString(inputString : String, string_to_be_concatenated: String) : String = {  
        inputString.concat("_" + string_to_be_concatenated)  
    }
```

Function as a variable

A function can be assigned to a variable.

In this case the original object is modified.

// A Function Name as a Variable

```
val functionNameAsVariable = (i:Int) => { i + 10}
```

The function as a variable which gets an input a string and return an integer.

```
val lengthOfString: String => Int = _.length
```

Use case : When the original object is to be modified, then you can use this methodology.

Function as a variable

```
val simpleList = List(1,2,3,4,5)
```

```
// A Function Name as a Variable  
val functionNameAsVariable = (i:Int) => { i + 10}
```

```
simpleList.map(functionNameAsVariable).foreach { x => println(x) }
```

Function as a variable

```
val fn = (x : Int) => x * x
```

// is expanded to

```
val fnAliter = new Function1[Int, Int] {  
  def apply(x : Int) : Int = {  
    x * x  
  }  
}
```

fn(3)
fn.apply(3)

fnAliter(3)
fnAliter.apply(3)

Partially Applied Function

```
val PRIMARY_SCHEMA = "PRIMARY"
val SECONDARY_SCHEMA = "SECONDARY"

def persist(schema : String) (query : String) = {
    println(s"Executing $query in $schema")
}

// Partially Applied Function
def executePAF() {
    val persistPrimary = persist (PRIMARY_SCHEMA) (_:String)
    val persistSecondary = persist (SECONDARY_SCHEMA) (_:String)

    persistPrimary("Select * from RegressionReckoner")
    persistSecondary("Select * from RegressionReckoner")
}
```

Currying

```
val PRIMARY_SCHEMA = "PRIMARY"
  val SECONDARY_SCHEMA = "SECONDARY"

  def curriedPersist(schema : String) = (query : String) => {
    println(s"Executing $query in $schema")
  }
```

```
// Currying Function
def executeCurrying() {
  val persistPrimary = curriedPersist (PRIMARY_SCHEMA)
  val persistSecondary = curriedPersist (SECONDARY_SCHEMA)

  persistPrimary("Select * from RegressionReckoner")
  persistSecondary("Select * from RegressionReckoner")
}
```

Currying

```
/** A curried function */
def concatTwoStrings(first:String) = (second:String) => {
    first.concat(second)
}

var result_1 = concatTwoStrings("CHERA")("CHOLA")
var result_2 = concatTwoStrings("PANDYA")
var result_3 = result_2("PALLAVA")

println(result_1)
println(result_2)
println(result_3)
```

A curried function is for a tuple input
PAF (Partially Applied Function)
is for multivariate inputs.

Output:

```
CHERACHOLA
<function1>
PANDYAPALLAVA
```

Type Specifications

Type Aliases

Type Aliases

Helps in elegant naming

Ease of functional programming and coding.

Type Aliases

```
object TypeAlias {  
  
    type MY_INTEGER = Int  
    type myString = String  
    type RT = Runtime  
    type EMPBEAN = EmployeeBean  
  
}
```

```
object TypeSpecification {  
  
    def main(args : Array[String]) {  
  
        val aInteger : TypeAlias.MY_INTEGER = 5  
        val aString : TypeAlias.myString = "Zeus"  
  
        val empBean : TypeAlias.EMPBEAN = new EmployeeBean  
  
    }  
}
```

Type Aliases

```
type UserInfo = Tuple2[Int, String]  
  
val userInfo = new UserInfo(1, "Chinnasamy")  
println(userInfo._2)
```

TypeSpecification.scala

Types

Type Abstraction

```
// Type lets you define the abstract behavior of a class/trait  
trait FileFormatter {
```

```
    type T
```

```
    def formatFile(): T  
}
```

```
class ParqueFileFormatter extends FileFormatter {
```

```
    override type T = String
```

```
    override def formatFile() = {  
        "RETURN-PARQUE-FILE"  
    }  
}
```

Type Classes

Type Classes

Type classes provide ad-hoc polymorphism, which states that one can create polymorphism that can be applied to arguments of different types.

Type classes help us by which we can create common behavior for classes without resorting to tradition inheritance (extends) polymorphism.

It's nothing but a programming pattern with the help of implicits.

Ad Hoc polymorphism refers to functions that can be applied to argument of different types.

Type Classes

- [0] Define the type classes
- [1] Define Behavior
- [2] Provide Implementation
- [3] Call the type classes

Type Classes

[0] Define the type classes

```
final case class REDIS_NOSQL(data : String)
```

```
final case class VOLDEMORT_NOSQL(data : String)
```

```
final case class COUCHDB_NOSQL(datas: String)
```

Type Classes

[1] Define Behavior

```
trait BigDataWriter[A]
{
    def writeToDB(input : A)
}
```

Type Classes

[2] Provide Implementation

```
object BigDataWriterUtility {

    implicit object MYSQLWriter extends BigDataWriter[REDIS_NOSQL] {
        override def writeToDB(input: REDIS_NOSQL) = {
            println(s"REDIS IS WRITTEN TO MYSQL $input")
        }
    }

    implicit class BigDataToDBConverter[A](input:A) {

        def writeToMYSQL(implicit writer : BigDataWriter[A]) = {
            writer.writeToDB(input)
        }
    }
}
```

Type Classes

[3] Call the type classes

```
object TypeClassesExplained extends App {  
  
    import BigDataWriterUtility._  
  
    REDIS_NOSQL("key-value").writeToMySQL  
  
}
```

Scala Generics

Scala Generics

Covariant

[+T] - Along the inheritance

Contravariant

[-T] - Against the inheritance

Invariant

[T]

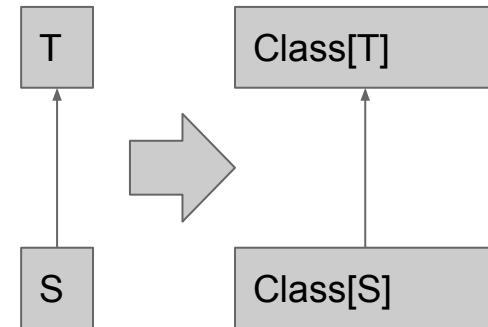
CovariantContravariantInvariant.scala

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Rules of Inheritance - Covariant

Covariant - [+A]

If S extends T, then class[S] also extends class[T]



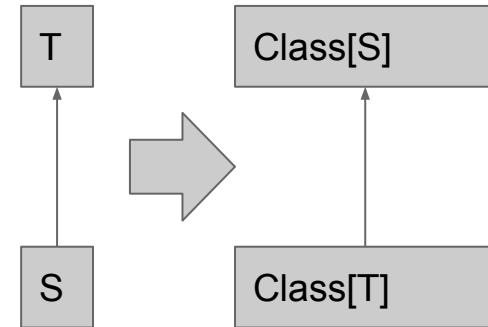
CovariantContravariantInvariant.scala

chinnasamyad@gmail.com

Rules of Inheritance - Contravariant

Covariant - [-A]

If S extends T, then class[T] also extends class[S]



CovariantContravariantInvariant.scala

chinnasamyad@gmail.com

Covariance

```
class  
CovariantFamily[+  
A] (val data : A)
```

```
tellMeWhomAmI(new CovariantFamily[Child] (new Child))
```

```
//invokeContravariant(new ContraVariantFamily[Parent] (new  
Parent))
```

```
def tellMeWhomAmI(family : CovariantFamily[Parent]) {  
    println(family.data.parentName)  
}
```

CovariantContravariantInvariant.scala

chinnasamyad@gmail.com

Variants are of three types in Scala

- 1. Covariant +T
- 2. Contravariant -T
- 3. Invariant T

Covariant - Only subtypes of the defined class

Contravariant - Only supertypes of the defined class

Invariant - Only the particular class

By default scala classes are invariants in nature.

Variants

```
// Covariant - Only subtypes of WildAnimals are fine
class Zoo1[+T] {

}

// Contravariant - Only supertypes of WildAnimals are fine
class Zoo2[-T] {

}

// Invariant - Only WildAnimals are fine. By default are scala classes
class Zoo3[T] {

}

class Animals

class WildAnimals extends Animals

class Lion extends WildAnimals
```

```
object VariantsOfClass {

    // Only subtypes of WildAnimals are fine
    def covariant(zoo : Zoo1[WildAnimals]) = {

    }

    // Only supertypes of WildAnimals are fine
    def contravariant(zoo : Zoo2[WildAnimals]) = {

    }

    // Only WildAnimals are fine. By default are scala classes are Invariant
    def invariant(zoo : Zoo3[WildAnimals]) = {

    }
}
```

Variants

```
def main(args : Array[String]) = {  
  
    covariant(new Zoo1[WildAnimals])  
    covariant(new Zoo1[Lion])  
    //covariant(new Zoo1[Animals]) // Compilation fails  
  
    contravariant(new Zoo2[WildAnimals])  
    //contravariant(new Zoo2[Lion]) // Compilation fails  
    contravariant(new Zoo2[Animals])  
  
    invariant(new Zoo3[WildAnimals])  
    //invariant(new Zoo3[Lion]) // Compilation fails  
    //invariant(new Zoo3[Animals]) // Compilation fails  
  
}
```

Bounds

Upper Bound

$S <: T$

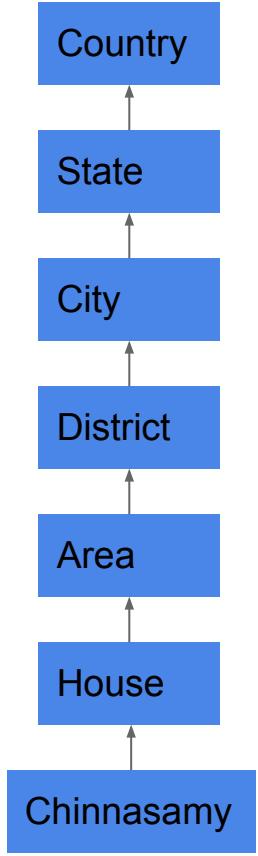
S is a subtype of T

Lower Bound

$S >: T$

S is a supertype of T

$S >: T <: U$



```
class Country {}  
class State extends Country {}  
class City extends State {}  
class District extends City {}  
class Area extends District {}  
class House extends Area {}  
class Chinnasamy extends House {}
```

Bounds

```
class World {  
  
    // Upper Bound  
    def isMyDistrict[S <: District](myDistrict:S) : S = {  
        println(myDistrict.getClass)  
        myDistrict  
    }  
  
    // Lower Bound  
    def giveMeAllSupers[S >: District](myDistrict:S) : S = {  
        println(myDistrict.getClass)  
        myDistrict  
    }  
  
    def giveIntermediate[S >: Area <: City](myLiving:S) : S = {  
        println(myLiving.getClass)  
        myLiving  
    }  
  
    class Country {}  
    class State extends Country {}  
    class City extends State {}  
    class District extends City {}  
    class Area extends District {}  
    class House extends Area {}  
    class Chinnasamy extends House {}  
  
    val world = new World  
    // world.isMyDistrict(new Area)  
    // world.isMyDistrict(new House)  
    // world.isMyDistrict(new Chinnasamy)  
    //world.isMyDistrict(new City) // Fails  
  
    // world.giveMeAllSupers(new City())  
    // world.giveMeAllSupers(new Country())  
  
    world.giveIntermediate(new District)  
    // world.giveIntermediate(new State) // fails  
    world.giveIntermediate(new House)
```

Variance

Variance Check =>

Function are contravariant in their argument type and covariant in their result type.

- Covariant type parameters can appear in method results.
- Contravariant type parameters can only appear in method parameters.
- Invariant type parameters can appear anywhere

Variance checks prevents mutable operations in covariant classes.

Bounds

Upper Bound

$S <: T$

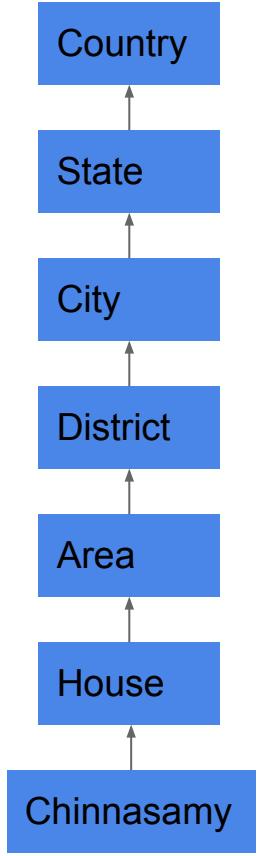
S is a subtype of T

Lower Bound

$S >: T$

S is a supertype of T

$S >: T <: U$



```
class Country {}  
class State extends Country {}  
class City extends State {}  
class District extends City {}  
class Area extends District {}  
class House extends Area {}  
class Chinnasamy extends House {}
```

Bounds

```
class World {  
  
    // Upper Bound  
    def isMyDistrict[S <: District](myDistrict:S) : S = {  
        println(myDistrict.getClass)  
        myDistrict  
    }  
  
    // Lower Bound  
    def giveMeAllSupers[S >: District](myDistrict:S) : S = {  
        println(myDistrict.getClass)  
        myDistrict  
    }  

```

```
def giveIntermediate[S >: Area <: City](myLiving:S) : S = {  
    println(myLiving.getClass)  
    myLiving  
}  
}
```

```
class Country {}  
class State extends Country {}  
class City extends State {}  
class District extends City {}  
class Area extends District {}  
class House extends Area {}  
class Chinnasamy extends House {}
```

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```
val world = new World  
// world.isMyDistrict(new Area)  
// world.isMyDistrict(new House)  
// world.isMyDistrict(new Chinnasamy)  
//world.isMyDistrict(new City) // Fails
```

```
// world.giveMeAllSupers(new City())  
// world.giveMeAllSupers(new Country())
```

```
world.giveIntermediate(new District)  
// world.giveIntermediate(new State) // fails  
world.giveIntermediate(new House)
```

Variance

Variance Check =>

Function are contravariant in their argument type and covariant in their result type.

- Covariant type parameters can appear in method results.
- Contravariant type parameters can only appear in method parameters.
- Invariant type parameters can appear anywhere

Variance checks prevents mutable operations in covariant classes.

Annotations Usage

```
object AnnotationsUsage {  
  
  def main(args : Array[String]) : Unit = {  
  
    @volatile  
    val volatileKeyword = "A_VOLATILE_DECLARATION"  
  
    @throws(classOf[MeshContractDataFlowException])  
    val dataFlow = new DataFlow  
  
    dataFlow.data("")  
  
  }  
}  
  
class DataFlow {  
  
  def data(message : String) = {  
    throw MeshContractDataFlowException("Dataflow exception")  
  }  
}  
  
case class MeshContractDataFlowException(message:String) extends Exception(message)
```

Bounded Types

Upper Bounded Type

Lower Bounded Type

Embrace functional programming

Instead of using the for loop use the foreach

```
def printArray(namesArray : Array[String]) : Unit = {  
    namesArray.foreach { x => println(x) }  
}
```

```
val names = Array("ALAN", "MATHISON", "TURING")  
clazz.printArray(names)
```

Embrace functional programming - compose , andThen Helpers

[*] Each function has a compose, andThen methods to help in functional programming.

[*] compose, andThen build bigger functions from smaller functions.

[*] The only difference between compose and andThen is that the order of execution is reversed.

Refer ThenAndComposePattern.scala

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Embrace functional programming - compose , andThen Helpers

```
def convertStringToInt(input : String) : Int = {  
    Integer.parseInt(input)  
}  
  
def convertIntToFloat(inputInteger : Int) : Float = {  
    inputInteger.toFloat  
}  
  
def convertFloatToString(inputFloat : Float) : String = {  
    inputFloat.toString  
}  
  
val convertStringToFloatUsingAndThen = convertStringToInt _ andThen convertIntToFloat _  
val convertStringToFloatUsingCompose = convertIntToFloat _ compose convertStringToInt _  
val mixOfComposeandThen = convertIntToFloat _ compose convertStringToInt _ andThen  
    convertFloatToString _  
  
println(convertStringToFloatUsingCompose("20"))  
println(mixOfComposeandThen("20"))
```

Refer ThenAndComposePattern.scala

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Embrace functional programming - compose , andThen Helpers

```
def getCSVSplitted(input : String) : Array[String] = {  
    input.split(",")  
}
```

```
def returnCSVFormattedString(fileName : String) : String = {  
    val file = Source.fromFile(fileName)  
    file.getLines().mkString  
}
```

```
def analyzeOntheData(inputArray : Array[String]) : Int = {  
    inputArray(2).length  
}
```

```
val getMeData = getCSVSplitted _ compose returnCSVFormattedString _ andThen analyzeOntheData _  
printIn(getMeData("/home/dharshekthvel/ac/code/scalatrainingintellij/data/titanic3.csv"))
```

Refer ThenAndComposePattern.scala

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Embrace functional programming - compose , andThen Helpers

```
def convertToUpperCase(input: String) : String = input.toUpperCase  
def returnLength(input : String ) : String = {  
    return input.length.toString  
}
```

val inputList = List("Kudu", "Apache", "Zeppelin")
/*
compose, andThen build bigger functions from smaller functions.
The only difference between compose and andThen is that the order
of execution is reversed.
*/
inputList.map(convertToUpperCase_andThen returnLength_)
.foreach(eachElement => println(eachElement))

PartialFunction

A PartialFunction is a trait that helps in concise code with the help of isDefinedAt() method.

A PartialFunction defines a isDefinedAt() method which helps the caller to know whether the function can handle that element.

Remember: A PartialFunction is no way related to Partially Applied Function (Currying)

PartialFunction

Implementing a PartialFunction...

```
class One extends PartialFunction[Int, String] {  
    override def isDefinedAt(x: Int): Boolean = if (x==1) true else false  
  
    override def apply(v1: Int): String = "ONE"
```

```
}
```

```
val one = new One
```

```
println(one(1))
```

ElucidatingPartialFunction.scala

PartialFunction

Implementing a PartialFunction...

```
val two = new PartialFunction[Int, String] {  
    override def isDefinedAt(x: Int): Boolean = if (x==2) true else false
```

```
    override def apply(v1: Int): String = "TWO"  
}
```

```
println(two(2))
```

ElucidatingPartialFunction.scala

PartialFunction

Implementing a PartialFunction...

```
val three: PartialFunction[Int, String] = { case 3 => "THREE" }
```

```
println(three(3))
```

ElucidatingPartialFunction.scala

PartialFunction

Implementing a PartialFunction...

```
val mypartialfunction = one orElse two orElse three orElse four
```

```
if (mypartialfunction.isDefinedAt 3)  
  println("Final Output : " + mypartialfunction(3))
```

ElucidatingPartialFunction.scala

Transformations, Grouping, Filtering Methods

Scala enablers to help in better programming on collections

Transformation, Filtering, Grouping methods are helper methods in collections provided in the scala API to enable ease in programming.

Apart from these there are also mathematical and data structure helper methods to facilitate ease of programming.

Filter

```
val countries = List("Brazil",
    "Russia",
    "Bahamas",
    "Bangladesh",
    "Cook Islands",
    "UK",
    "Norway",
    "Sweden",
    "Germany",
    "France")
```

```
countries.filter { x => x.startsWith("B") }.foreach { x => println(x) }
```

```
countries.filter { (x:String) => x.startsWith("B") }.foreach { x => println(x) }
```

```
countries.filter ( _.startsWith("B") ).foreach { x => println(x) }
```

Filter

```
case class SupportVectorMachineBean (var name : String,  
                                   var highSupportVector : Float,  
                                   var lowerSupportVector : Float)
```

Exercise

```
val svmList =  
    List(  
        SupportVectorMachineBean("AverageCallHandlingTime", 12f, 1f),  
        SupportVectorMachineBean("SupervisorMetric", 15f, 7f),  
        SupportVectorMachineBean("GYRScore", 2f, 1f),  
        SupportVectorMachineBean("CallMetricRatio", 9f, 4f))
```

Filter

```
svmList.filter { svmBean => svmBean.lowerSupportVector > 2f }  
  .foreach { vector => println(vector.name) }
```

```
    svmList.filter (_ .lowerSupportVector > 2f).foreach( vector =>  
      println(vector.name))
```

Head and Tail Filter

head returns the first element. Tail returns all elements except the first element.

```
val countries = List("Brazil",
                     "Austria",
                     "Bahamas",
                     "Bangladesh",
                     "Cook Islands")

println("Tail Elements")
countries.tail.foreach { x => println(x) }

println("Head Element")
println(countries.head)
```

Take and Drop Filter

take(n) returns the first n elements.

drop(n) returns all except the first n elements.

```
val countries = List("Brazil",
                     "Austria",
                     "Bahamas",
                     "Bangladesh",
                     "Cook Islands")
```

```
println("Take Elements")
countries.take(3).foreach { x => println(x) }
```

```
println("Drop Elements")
countries.drop(3).foreach { x => println(x) }
```

find Filter

```
val countries = List("Brazil",
    "Russia",
    "Bahamas",
    "Bangladesh",
    "Cook Islands",
    "UK",
    "Norway",
    "Sweden",
    "Germany",
    "France")
```

Returns the Some of the Option class.

Returns the first occurrence of the search satisfying the predicate.

```
countries.find { x => x.startsWith("Ba") }.foreach { x => println(x) }
```

Map Transformation

```
val countries = List("Brazil",
    "Austria",
    "Bahamas",
    "Bangladesh",
    "Cook Islands")
```

```
countries.map { country => country.concat("_Country") }
.foreach { x => println(x) }
```

Map Transformation

```
val countries = List("Brazil",  
                     "Austria",  
                     "Bahamas",  
                     "Bangladesh",  
                     "Cook Islands")  
  
case class CountryNameBean(var name: String)  
  
val countryList = countries  
    .map(country => CountryNameBean(country)).toList  
  
//countryList.foreach { x => println(x.name) }
```

Transformations.scala

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Map Transformation

Exercise

```
val svmList =  
  List(  
    SupportVectorMachineBean("AverageCallHandlingTime", 12f, 1f),  
    SupportVectorMachineBean("SupervisorMetric", 15f, 7f),  
    SupportVectorMachineBean("GYRScore", 2f, 1f),  
    SupportVectorMachineBean("CallMetricRatio", 9f, 4f))
```

```
case class SupportVectorMachineBean (var name : String,  
                                    var highSupportVector : Float,  
                                    var lowerSupportVector : Float)
```

```
case class SVMNameBean(var name : String)
```

Transformations.scala

Map Transformation

```
svmList.filter(_.lowerSupportVector > 2f).map { x => SVMNameBean(x.name)}.toList
```

Transformations.scala

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 Scala
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Map Transformation

```
case class CountryNameCodeBean(var name: String, var code: String)
```

```
val countryNameCodeList = countryList
    .map(x => new CountryCodeBeanTransformation().mapToCountryCode(x)).toList

countryNameCodeList.foreach { x => println(x.name) }
```

```
class CountryCodeBeanTransformation {

    def mapToCountryCode(countryNameBean : CountryNameBean) : CountryNameCodeBean = {

        if (countryNameBean.name == "Brazil") CountryNameCodeBean(countryNameBean.name, "BR")
        else if (countryNameBean.name == "Austria") CountryNameCodeBean(countryNameBean.name, "AU")
        else CountryNameCodeBean(countryNameBean.name, "_NO_CODE_")
    }
}
```

Transformations.scala

flatMap() Transformation

flatMap() flattens the data structure

Difference between a map() and flatMap()

```
val computationFunction = (i: Int) => List(i*4)
```

```
val originalList = List(1,2,3)
```

```
val mappedList = originalList.map(computationFunction)
```

```
val flattenedList = originalList.map(computationFunction).flatten  
val flatMapList = originalList.flatMap(computationFunction)
```

```
println(mappedList)      // List(List(4), List(8), List(12))  
println(flattenedList)   // List(4, 8, 12)  
println(flatMapList)     // List(4, 8, 12)
```

count() Transformation

(Mathematical Informational Transformation)

```
count(<<predicate>>)
```

count returns the count of elements satisfying the predicate

```
val countries = List("Brazil",  
                     "Austria",  
                     "Bahamas",  
                     "Bangladesh",  
                     "Cook Islands")
```

```
val countOfCountries = countries.count(element => element.startsWith("B"))
```

collect Transformation

The collect() transformation transforms the given data as per the logic been written inside the partial function passed to the collect.

collect Transformation

```
val partialFunction : PartialFunction[String, String] =  
{  
    case eachElement: String =>  
        eachElement.concat(" - CHOLA")  
}
```

```
val list = List ("CHERA", "PANDYA", "PALLAVA")
```

```
list .collect(partialFunction)  
    .foreach(eachElement => println(eachElement));
```

Zip Transformation

Zip Transformation does a one to one combination and produces another collection

```
val country = List("Austria", "Bahamas", "Cook Islands")
val code = List("AT", "BS", "CK")
```

```
val zippedList = code.zip(country)
zippedList.foreach(x => println(x))
```

(AT,Austria)
(BS,Bahamas)
(CK,Cook Islands)

Zip Transformation With Index

Zip with Index zip's the list with the indices starting from zero.

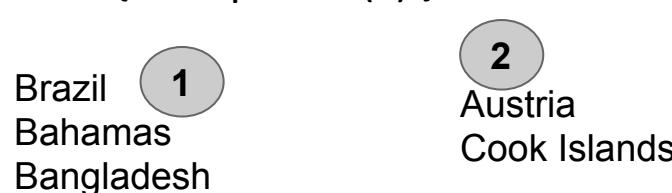
```
val country = List("Austria", "Bahamas", "Cook Islands")
val zippedList = country.zipWithIndex
zippedList.foreach(x => println(x))
```

(Austria,0)
(Bahamas,1)
(Cook Islands,2)

Partition

```
val countries = List("Brazil",  
                     "Austria",  
                     "Bahamas",  
                     "Bangladesh",  
                     "Cook Islands")
```

```
val partitionedList = countries.partition { country => country.startsWith("B") }  
partitionedList._1.foreach { x => println(x) }  
partitionedList._2.foreach { x => println(x) }
```



reduce Transformation

reduce is a transformation that executes the code written inside the function on the data set.

Basically a reduction on the data set.

```
val listOfNumbers = List(1,2,3,4,5)
```

```
val result = listOfNumbers.reduceLeft(_ + _)
```

```
println(result)
```

reduce Transformation

```
val stringList = List("A", "String", "in", "a", "list")
```

```
val resultList = stringList.reduceLeft((x,y) => x.concat(" ").concat(y))
```

```
println(resultList)
```

fold, foldLeft, foldRight

In a nutshell, fold takes data in one format and gives you in another based upon the function logic.

fold takes a seed value as one extra parameter.

reduce transformation acts on the data set in the same way as fold, but reduce doesn't have a seed value as that of fold.

reduce transformation uses the first element as the seed value.

foldLeft

foldLeft operation to sum the numbers of the list.

```
val listOfNumbers = List(1,2,3,4,5)
```

```
val result = listOfNumbers.foldLeft(0)(_ + _)
```

```
println(result)
```

foldLeft

A foldLeft operation to concatenate elements in a list

```
val stringList = List("A", "String", "in", "a", "list")
```

```
val resultList = stringList.foldLeft("The final String is : ")((x,y) => x.concat(" ")).concat(y))
```

```
println(resultList)
```

foldLeft

foldLeft operation to sum the numbers from 1 to 1000

```
val rangeOfNumbers = 1 to 1000
```

```
val rangeResult = rangeOfNumbers.foldLeft(0)((x,y) => x+y)
```

```
println(rangeResult)
```

foldLeft - Usage

```
def length(list: List[String]): Int = list.foldLeft(0) { (count, _) => count + 1 }
```

```
def lastElement(list: List[String]): String = list.foldLeft("") { (a, b) => b }
```

```
val myList = List("FUNCTOR",
                  "APPLICATIVE",
                  "SEMIGROUP")
```

```
val size = length(myList)
```

```
val last = lastElement(myList)
```

```
println(last)
```

Parallel Sequence Transformation

par method returns a parallel sequence on the collection

```
val countries = List(  
    "Brazil",  
    "Russia",  
    "Bahamas",  
    "Bangladesh",  
    "Cook Islands")  
  
countries.par.foreach { z => println(z) }
```

Flatten Transformation

```
val countries = List("Brazil",  
                     "Russia",  
                     "Bahamas",  
                     "Bangladesh",  
                     "Cook Islands")
```

```
val europeanCountries = List("UK",  
                             "Norway",  
                             "Sweden",  
                             "Germany",  
                             "France")
```

```
val allCountries = List(countries,  
                        europeanCountries)
```

```
val flattenedListOfCountries =  
  allCountries.flatten  
  flattenedListOfCountries.foreach { x =>  
    println(x) }
```

Slice Transformation

```
val countries = List("Brazil",  
  "Russia",  
  "Bahamas",  
  "Bangladesh",  
  "Cook Islands")
```

```
countries.slice(1,3).foreach(x => println(x))
```

Russia
Bahamas

SplitAt Transformation

```
val countries = List("Brazil",
  "Russia",
  "Bahamas",
  "Bangladesh",
  "Cook Islands")

countries.splitAt(2)._1.foreach(x => println(x))
```

Since we are printing `_1` of the tuple, we get the first split.

```
Brazil
Russia
```

Reverse Transformation

Returns the elements in the reversed order

```
val countries = List("Brazil",
    "Russia",
    "Bahamas",
    "Bangladesh",
    "Cook Islands",
    "UK",
    "Norway",
    "Sweden",
    "Germany",
    "France")
```

```
countries.reverse.foreach { x => println(x) }
```

implicit

The implicit feature in the code allows the scala compiler to adjust code using a lookup mechanism.

implicit can be thought of as a global initializer or identifier.

implicit can either be defined on the variable, method, class or an object.

implicit

An implicit on the variable

```
implicit val floatValue = 167f
```

```
def getMeRoundedNumberOfFloat(implicit anyFloatValue : Float) {  
    println(anyFloatValue)  
}
```

```
def main(args: Array[String]) {  
    getMeRoundedNumberOfFloat  
}
```

Implicit methods

An implicit on the method level

```
implicit val defaultHoursOfWork = 8
```

```
def work(nameOfPerson: String) (implicit durationOfWork : Int) = {  
  println("Name of the person and the hours he worked - " + nameOfPerson + " - " + durationOfWork)  
}
```

```
work("Che")  
work("Che")(10)
```

Name of the person and the hours he worked - Che - 8
Name of the person and the hours he worked - Che - 10

Implicit - Another Usage

An implicit on the method level

```
def printAge(name : String) {  
    println(s"printing age of $name")  
}
```

```
implicit def printName(age : Int) : String = {  
    println("obtaining name")  
    "CHINNASAMY"  
}
```

```
/* Two implicit functions cannot be possible  
implicit def getName(age: Int) : String = {  
    ""  
} */
```

```
def main(args: Array[String]) {  
    printAge(12)  
}
```

implicit

implicit classes as extension methods

```
object ImplicitClassesFeature {  
  
    implicit class AddFunctionalityToString(val input: String) {  
  
        def letMoonBeAddedToString(): String = input.concat("MOON")  
    }  
  
}
```

```
import com.dmac.basic.ImplicitClassesFeature._  
val out = "NLP_".letMoonBeAddedToString()  
println(out)
```

The String is enriched with the API
letMoonBeAddedToString().

Implicit classes are usually put inside a **object**. So that **import** can be easy.
Implicit classes can have only one constructor argument
Implicit classes cannot have two classes with the same input type variable.
Implicit classes must be defined inside a trait (or) class (or) object.
Ofcourse, Implicit classes should be imported in the current scope.

implicit

implicit classes as extension methods

```
val money = 100;  
println("Printing the implicit" + 100.words)
```

The Integer money is enriched with the API words().

```
implicit class MoneyToWords(val n: Int) {  
  def words(): String = {  
    if (n == 100) "One Hundred"  
    else if (n == 200) "Two Hundred"  
    else "No Money"  
  }  
}
```

Refer ImplicitFeature.scala

implicit

implicit on object

```
import org.apache.spark.{SparkContext, SparkConf, AccumulatorParam}

implicit object AuthSuccessAccumulator extends AccumulatorParam[AuthSuccess] {

  override def addInPlace(r1: AuthSuccess, r2: AuthSuccess): AuthSuccess
    = AuthSuccess(r1.uid + " - " + r2.uid)

  override def zero(initialValue: AuthSuccess): AuthSuccess = AuthSuccess("")

}
```

File Operations

scala.io

Reading a File

Simple one liner for reading each line in of a file.

```
import scala.io.Source

def readingAFile(fileName : String) : Unit = {
    Source
        .fromFile(fileName)
        .foreach { print }
}
```

File Read

```
def readFile(fileName: String) : Unit = {  
    val file = io.Source.fromFile(fileName)  
  
    for(line <- file.getLines())  
        println(line)  
  
    file.close  
}
```

FileOperations.scala

Reading a CSV File

```
import scala.io.Source

/*
 * Created by dharshekthvel on 9/9/17.
 */

object ReadCSV extends App {

  val bufferedSource = Source.fromFile("/tmp/finance.csv")

  for (line <- bufferedSource.getLines()) {
    val cols = line.split(",").map(_.trim)
    println(cols(0))
  }

  bufferedSource.close
}
```

CSV File Read

```
val csvFile = io.Source.fromFile(fileName)

for(line <- csvFile.getLines()) {
    val columns = line.split(",")
    println(columns(0) + " " + columns(2))
}

csvFile.close
```

FileOperations.scala

CSV File Read

```
case class AuthBean(val authCode:String, val auaCode : String)

val list = new ListBuffer[AuthBean]

for(line <- csvFile.getLines()) {
    val lines = line.split(",")
    val ab = AuthBean(lines(0), lines(2))
    list += ab
}

val authBeanList = list.toList
authBeanList.foreach { authBean => println(authBean.authCode) }

csvFile.close
```

FileOperations.scala

CSV File Read

```
case class AuthBean(val authCode:String, val auaCode : String)

val list = new ListBuffer[AuthBean]

// Functional way
csvFile.getLines().foreach { line =>
    val column = line.split(",")
    val ab = AuthBean(column(0), column(2))
    list += ab
}

val authBeanList = list.toList
authBeanList.foreach { authBean => println(authBean.authCode) }

csvFile.close
```

FileOperations.scala

Continuously read a stream

```
val file = "/var/log/syslog"  
val tail = Seq("tail", "-f", file)
```

```
println(tail)  
import scala.sys.process._  
tail.lineStream.foreach(println(_))
```

Read a log file

```
val lines = Source.fromFile("/home/dharshekthvel/java_error_in_IDEA_7548.log")  
  .getLines()  
  .toList
```

```
println(lines.takeRight(10))
```

Executing External Command

```
import sys.process._

val LS_COMMAND = "ls -l".!!

println(LS_COMMAND)
```

Executing External Command

!

!!

lines() - Returns a Stream of string

sbt - Scala Build Tool

\$ sbt package

Will create a jar without any dependencies.

\$ sbt assembly

Will create a jar with all dependencies.

\$ sbt clean

Deletes the target directory

\$ sbt publish

Publishes the artifacts

sbt - Scala Build Tool

sbt run

Runs the main class

\$ sbt clean dist

To create a complete packaging distribution

sbt - run

if there are
more than
one executable file,
sbt would
ask for the prompt.

```
[info] Set current project to sparkscala9 (in build file:/D:/ac/sparkscala9  
[warn] The global sbt directory is now versioned and is located at C:\Users\HCL\.sbt\0.13.  
[warn] You are seeing this warning because there is global configuration in C:\Users\HCL\.sbt but not in C:\Users\HCL\.sbt\0.13.  
[warn] The global sbt directory may be changed via the sbt.global.base system property.  
[info] Compiling 25 Scala sources to D:/ac/sparkscala9/target/scala-2.11/classes...  
[warn] ...  
[warn] there were two deprecation warnings; re-run with --deprecation for details  
[warn] one warning found  
[warn] Multiple main classes detected. Run 'show discoveredMainClasses' to see the list  
  
Multiple main classes detected, select one to run:  
[1] CustomRDD  
[2] DataFrameManipulator  
[3] ElucidateDataset  
[4] SparkGlom  
[5] SparkMain  
[6] StructTypeDemo  
[7] com.dmac.scala.CustomPartitioner  
[8] com.dmac.scala.MapPartitions  
[9] com.dmac.scala.SparkElasticSearch  
[10] com.dmac.scala.WholeTextFilesSpark  
[11] com.dmac.scala.basic.SimpleMain  
[12] com.dmac.scala.basic.CaseClassExample  
[13] com.dmac.scala.basic.CovariantContravariantInvariant  
[14] com.dmac.scala.basic.CustomAccumulator  
[15] com.dmac.scala.basic.IteratingATuple  
[16] com.dmac.scala.basic.JDBCConnector  
[17] com.dmac.scala.basic.ListToBean  
[18] com.dmac.scala.basic.PartialFunctionMediocre  
[19] com.dmac.scala.basic.RangesOnCharacters  
[20] com.dmac.scala.basic.SomeOtherFile  
[21] com.dmac.scala.basic.SparkReadFile  
[22] com.dmac.scala.basic.SparkTransformations  
[23] com.dmac.scala.basic.WordCountSpark  
[24] com.dmac.scala.main.FirstScalaProgram  
  
Enter number: 1
```

Metadata Information

Use the classOf to get information about the class

```
val clazz = classOf[ETMS]
```

```
println(clazz.getName)  
println(clazz.getInterfaces)  
println(clazz.getConstructors)
```

```
class ETMS(parameter : String) extends AbstractTMS{  
  
    val appName = "Enterprise Trouble Management System";  
  
    def getTotalTickets() : Int = {  
        100  
    }  
}
```

Metadata.scala

XML File Read

The load function loads the xml file.

```
import scala.xml._  
  
val file = XML.load("D:/ac/data/food.xml")
```

XML File Read

```
<food>
    <name>Belgian Waffles</name>
    <price>$5.95</price>
    <description>Two of our famous Belgian Waffles with plenty of real maple syrup</description>
    <calories>650</calories>
</food>
<food>
    <name>Strawberry Belgian Waffles</name>
    <price>$7.95</price>
    <description>Light Belgian waffles covered with strawberries and whipped cream</description>
    <calories>900</calories>
</food>
```

```
val file = XML.load("D:/ac/data/food.xml")
val food = file \ "food" \ "name"
```

```
food.foreach { element => println(element.text) }
```

Scala Best Practices

Use the Option class where ever possible

Encapsulate each object inside the Option class

Null values are avoided and so NullPointerException is completely wiped off.

Either return Option or None.

Option basically returns the Some.

The Option class is a typical example of the sealed class.

Use the Option class where ever possible

```
val optionClazz = new UsageOfOption
  val returnValue = optionClazz.divide(3.5, 9.0)

  println(returnValue.get)
  println(optionClazz.upperCaseLogger(null))

  val value = optionClazz.upperCaseLogger("logging otp cache failure").get
  //println(optionClazz.upperCaseLogger("logging otp cache failure"))
  println(value)
```

```
class UsageOfOption {

  def divide(value : Double, divisor: Double) : Option[Double] = {
    if (divisor == 0) None
    else
      Option(value/divisor)
  }

  def upperCaseLogger(inputText : String) : Option[String] = {
    if (inputText == null || inputText.isEmpty()) None
    else {
      val message = "APP_NAME LOG : ".concat(inputText)
      Option(message)
    }
  }
}
```

Factory Pattern using match

```
val input = "QuickSearch"

val search = input match {

    case "QuickSearch" => new QuickSearch
    case "TimSearch" => new TimSearch

    case _ => new TimSearch
}

search.doSearchAlgorithm
```

```
trait Search {
    def input {
        //Get the Input
    }
    def doSearchAlgorithm
}

class QuickSearch extends Search {
    def doSearchAlgorithm {
        println("Quick Search Algorithm")
    }
}

class TimSearch extends Search {
    def doSearchAlgorithm {
        println("Tim Search Algorithm")
    }
}
```

Refer to [Matcher.scala](#)

Design by contract

Use the require() to achieve Design by Contract.

```
def designByContract(member : String) {  
    require(!member.isEmpty(), "MethodClass : member should not be empty")  
}
```

ScalaMethods.scala

Refer to [Matcher.scala](#)

Stuffs that you can do with scala

```
def printMeManyTimes(): String = {  
    return "*" * 100  
}
```

```
println(printMeManyTimes)
```

Stuffs that you can do with scala

You can mark a function as inline.

```
@inline def divide(value : Double, divisor: Double) : Option[Double] = {  
    ....  
    ....  
    ....  
}  
  
Try it for yourself whether  
it really optimizes the  
compiler
```

Inline functions places the function code in the place where it is called.

Tail Recursion

If the last action of a function consists of calling a function(which may be the same), one stack frame would be sufficient for both functions. Such calls are called tail-calls.

If a function calls itself as its last action, the functions stack frame can be reused. This is called tail-recursion.

Tail Recursion

```
def factWithOutTailRecursion(n : Int) : Int = {  
    if (n==0) 1 else n * factWithOutTailRecursion(n-1)  
}
```

```
def factWithTailRecursion(n : Int) : Int = {  
    loop(1,n)  
}
```

```
def loop(acc: Int, n: Int) : Int = {  
    if (n==0) acc else loop(acc*n, n-1)  
}
```

```
println(factWithOutTailRecursion(5))  
println(factWithTailRecursion(5))
```

Premature optimization is the root of all evil.

Tail Recursion

```
def factWithOutTailRecursion(n : Int) : Int = {  
    if (n==0) 1 else n * factWithOutTailRecursion(n-1)  
}
```

```
def factWithTailRecursion(n : Int) : Int = {  
    loop(1,n)  
}
```

```
def loop(acc: Int, n: Int) : Int = {  
    if (n==0) acc else loop(acc*n, n-1)  
}
```

```
println(factWithOutTailRecursion(5))  
println(factWithTailRecursion(5))
```

Premature optimization is the root of all evil.

Interoperability with Java

```
import scala.collection.JavaConverters._
```

Use the above import and you can use all conversions possible.

The above import adds a numerous implicit methods to your existing collection.

```
topicPartition.asList
```

Dynamic Method Invocation

Dynamic invocation feature of scala which allows you to call methods and variables dynamically without defining them in the class.

The DMI can be of greatest abstraction when building platform level code.

DMI.scala

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Dynamic Method Invocation

```
class FraudAnalyticsData extends Dynamic
{
  var map = Map.empty[String, Any]

  def selectDynamic(name: String) = map.get(name)

  def updateDynamic(name: String)(value: Any) {
    map += name -> value
  }

  def applyDynamic(name: String)(args: Any*) = {
    for (each <- args) {
      println(name + each)
    }
  }

  def applyDynamicNamed(name: String)(args: (String, Any)*) = {
    for (each <- args) {
      println(name + each)
    }
  }
}
```

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```
import scala.language.dynamics

val fad = new FraudAnalyticsData

// The below would call the selectDynamic() method
fad.name = "DATA_LEGITIMATE"
fad.name = "DATA_LEGITIMATE_OVERRIDE"

// The below method would call the applyDynamic() method
fad.dMethod(1, "2", 3f)

// The below method would call the applyDynamicNamed() method
fad.nameMethodCall(data="citrix", data2="install_shield", data3="kafka")

// The below would call the updateDynamic() method
println(fad.name)
```

Futures

Futures are asynchronous processing units in scala which process data in a concurrent and non-blocking way.

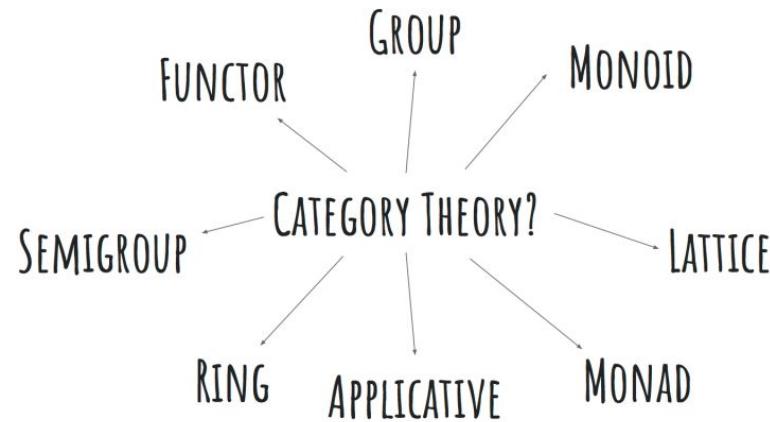
Futures

```
import scala.util.{Failure, Success}  
import scala.concurrent.ExecutionContext.Implicits.global  
import scala.concurrent.Future
```

```
val variable = Future {  
    <<block_of_code>>  
}
```

```
val executeMeFuturistically = Future {  
    Thread.sleep(1000)  
    println(1+1)  
    1+1  
}
```

Functional Paradigms



Category Theory

Category theory is the branch of math which formalizes a graph based structure in which nodes are objects and edges are called arrows.

Many of the functional programming paradigms are based and inspired from category theory.

Based on the category theory the abstraction of functional programming is built upon.

Real Functional Concepts

Semigroup

Monoid

Functor

Monad

Would be using cats library of scala for better understanding.

Semigroup

A mathematical object defined on a set which has the following properties:

1. Contains a binary operation, usually.
2. Can contain any operation,
3. The operation is associative.
3. A semigroup can be empty.

Semigroup

```
import cats.Semigroup
import cats.implicits._

val sg = Semigroup[Int].combine(3,4)
val sgOne = 3 |+| 4

println(sgOne)
println(sg)
```

Semigroup

```
val semigroup = Semigroup[Int => Int]
```

```
val a = Semigroup[Int => Int].combine({ (x: Int) => x + 1},  
                                         { (y: Int) => y * 10})
```

```
val b = Semigroup[Int => Int].combine({ (x: Int) => x + 2},  
                                         { (x: Int) => x * 20})
```

```
val c = a |+| b
```

```
print(c(1))
```

Monoid

A semigroup with a identity is called a monoid.

A monoid must have atleast one element.

Functor

Put it simple, a *functor* is a map function applied to a container.

1. Unwrap the values from the container
2. Apply the fn to all the values.
3. Put back the values to the container

Scalaz provides a functor implementation.

```
trait Functor[F[_]] extends functor.Invariant[F] { self => def map[A, B](fa: F[A])(f: A => B): F[B] }
```

Functor

A functor is a type class which implements a map method as below.

```
def map[A, B](fa: F[A])(f: A => B): F[B]
```

(fa : F[A]) – a data-type that take only one data-type e.g List, Future , Options

(f: A => B) – a function that transform a type A to a type B e.g function that takes a string and return an Int.

F[B] – the final return type of the Functor's map function e.g if our "fa" variable is a List[String] and our "f" function is String => Int , then our map function return type will be a List[Int]

Functor

```
// [1] Way of implementing a functor
```

```
val lengthOfString: String => Int = _.length
```

```
val list = List ("Data", "Ingestion")
```

```
val lengthOfList = list.product(lengthOfString)
```

```
println(lengthOfList)
```

```
println(lengthOfList.toMap)
```

```
// [2] Second way of implementing a functor
```

```
implicit val listFunctor: Functor[List] = new Functor[List] {
```

```
def map[A, B](fa: List[A])(f: A => B) = fa map f
```

```
}
```

```
val resultList = listFunctor.map(list)(_.length)
```

```
println(resultList)
```

```
// [3] Third way of implementing a Functor
```

```
val functorList = Functor[List].map(List("HBase",  
"FLASK-SERVER-INGESTION"))(_.length)
```

```
println(functorList)
```

Monad

A Monad is a parametric type with two operations.

The concept monad comes from *category theory*.

flatMap

Unit

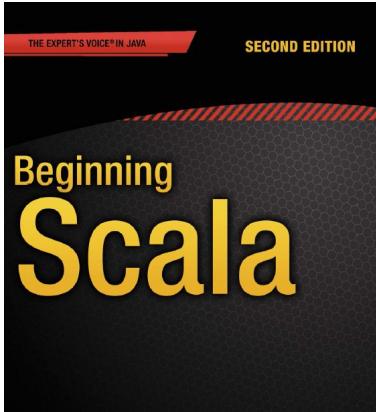
It should qualify the laws of associativity, Left Unit and Right Unit.

List, Set, Option, Generator are all monads.

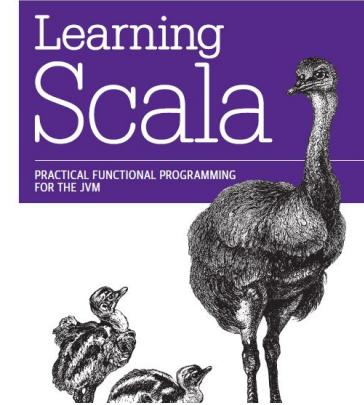
Monad

All monads are functors. Not all functors are monads.

References



O'REILLY®



Concurrency



Reactive Programming

<http://www.reactivemanifesto.org/>

Reactive Programming

Responsive : System responds in a timely manner.

Resilient : System is fault-tolerant.

Elastic : System is responsive under varying Workload.

Message-Driven : System uses asynchronous mode of messaging

Akka

The concept in akka was developed by Carl Hewitt, Peter Bishop and Richard Steiger in 1973.

The concept of actors is used in **Erlang** language and used by **Ericsson (telecom domain)** to build massive systems after which the actor based programming model became popular.

Akka is heavily influenced from the Erlang way of programming with actors.

Akka

An open-source project built by Light-Bend.

Akka is centered on actors. An actor based programming model.

By actors, actor way of programming,

One can isolate failure,
provide non-blocking I/O
and no shared mutable state for prone errors.

Akka

Forget the old way of programming by worrying about shared state, state visibility, threads, locks, concurrent collections etc.,

With actors, the lower level concurrency becomes the workflow of the framework.

Akka - Programming advantages

No boiler plate code.

Easily scalable from a laptop code to that of a datacenter.

Dont mix concurrency code with that of business logic.

The abstraction level of threads has been raised to much more higher level.

Actor

Akka's unit of code organization is called an actor.

The fundamental unit of computation in akka is called actor.

Actor

An actor is an object that receives messages and takes action based on the logic

It processes the messages or forwards the messages to another actor.
All actors execute concurrently.

To implement an Actor, extend the actor trait and implement the receive method.

All phenomenon, of creating threads, race condition, synchronization is all handled by akka internally.

Actor

Is a Message passing concurrency

Is a light-weight process

Does not share anything

Communicates with messages

Asynchronous and non-blocking

No shared state - So nothing to synchronize

Spark communicates with akka based model.

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Actor

Each actor has a mailbox.

Non-blocking send, but a blocking receive.

Messages are immutable.

Highly performant and scalable.

Avoids race-conditions, deadlocks, locks etc.,

Spark communicates with akka based model.

Actor

In short, Concurrency with threads are difficult, but with akka actors is pretty much easy.

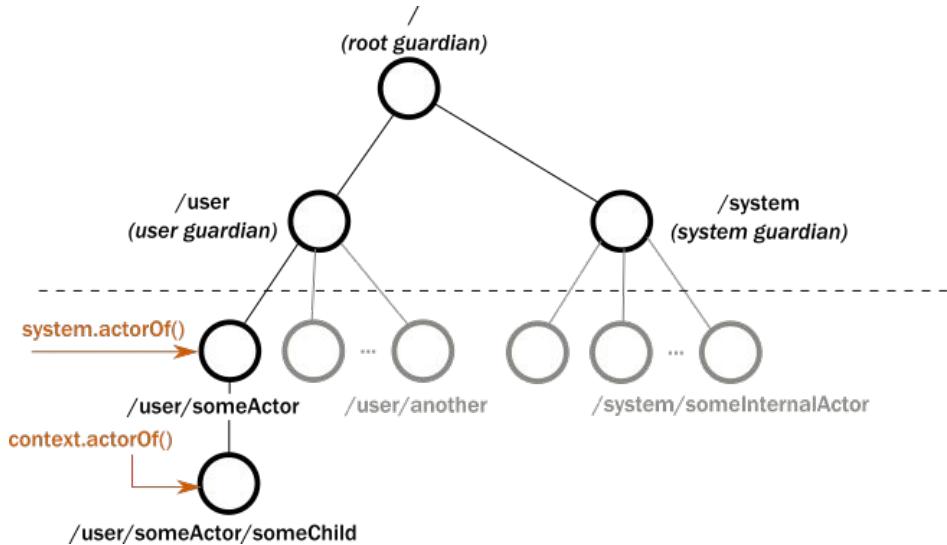
An actor is a light-weight process:

Create, Send, Become and Supervise.

Actor - Creation and Send Messages

Also called as Fire-and-Forget.

ask() : Send-and-Receive-Future



Concurrent App - Actors

```
import akka.actor.ActorSystem
import akka.actor.Actor
import akka.actor.Props

val system = ActorSystem("ConcurrentApp")
val sender = system.actorOf(Props[Receiver], "receiver")
```

Concurrent App - Actors

```
class Receiver extends Actor {  
    def receive = {  
        case "MESS" => println("message is received")  
  
        case Bean(name) => println(s"Got it $name")  
        case _ => println("_DEFAULT_")  
    }  
}
```

Concurrent App - Actors

```
val sender = system.actorOf(Props[Receiver], "receiver")
```

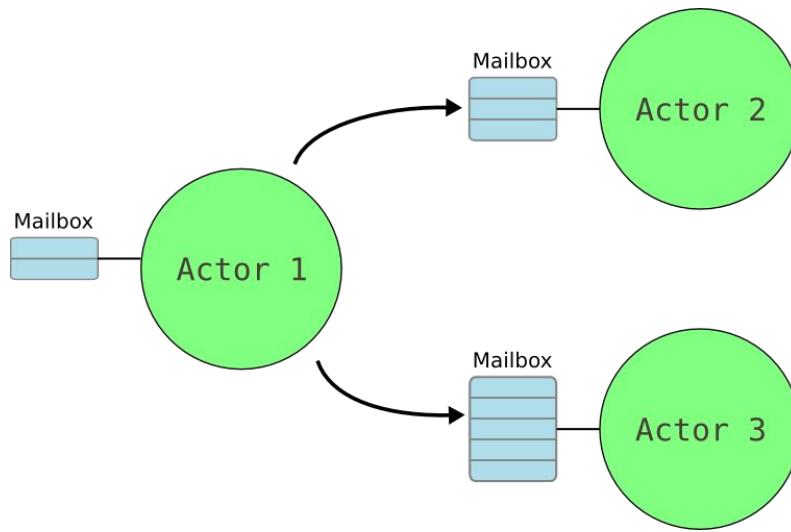
```
sender ! "MESS"  
sender.tell("MESS", sender)
```

```
val messageBean = Bean("bean")  
sender.tell(messageBean, sender)
```

Creating an actor and sending a message

1. Create an actor system.
2. From the actor system, create an actor.
3. An actor should be coded to receive messages.
4. Send the message to the actor - tell() or !.
5. ActorSystem terminate()

Creating an actor and sending a message



Actors send messages asynchronously.

Actors process messages sequentially.

Every actor has a **mailbox** associated with it.

Creating an actor and sending a message

```
object ActorInvocation {  
  
  def main(args: Array[String]): Unit = {  
  
    val actorSystem = ActorSystem.create()  
    val masterActor = actorSystem.actorOf(Props[Master], name = "Master")  
  
    // Actors can be of strings, case_classes etc.,  
    masterActor ! "MASTER-HIT"  
  
    masterActor ! MeshData("TIME_LINE", 99876)  
  
    // Either ! or tell. Both are same.  
    masterActor.tell(999, masterActor)  
  
    actorSystem.terminate  
  }  
}
```

```
class Master extends Actor {  
  
  def receive = {  
  
    case "MASTER-HIT" => println("Received message in master")  
  
    case 999 => println("Received message in master 999")  
  
    case MeshData(timeline: String, id: Int) => println(s"The timeline data is  
$timeline and id is $id")  
  
    case _ => println("Executing in master")  
  }  
}
```

Create: send a message, reply to it

```
val system = ActorSystem("HelloSystem")
// default Actor constructor
val helloActor = system.actorOf(Props[HelloActor], name = "helloactor")

// Fire and forget
helloActor ! "hello"

implicit val timeout = Timeout(5 seconds)
val returnMessage = helloActor ? "ack"

val result = Await.result(returnMessage, timeout.duration).asInstanceOf[String]
println(result)
```

```
class HelloActor extends Actor {
def receive = {
  case "hello" => println("hello back at you")
  case "ack" => sender() ! "message-received"
  case _      => println("huh?")
}
```

Child actors

```
class SparkWorker extends Actor {  
  
  def receive = {  
  
    case "process" => {  
      println("Processing message in worker")  
    }  
    case 0 => {  
      println("Exiting actor.")  
      context stop self  
    }  
    case _ => println("Executing in master")  
  }  
}
```

```
class SparkMaster extends Actor {  
  
  def receive = {  
  
    case "create-child" => {  
      println("Received message in master")  
  
      val range = 1 to 1000000000  
  
      for (i <- range) {  
        var name = "worker"  
        val masterActor = context.actorOf(Props[SparkWorker], name = name+i)  
        masterActor ! "process"  
      }  
    }  
    case 0 => {  
      println("Exiting actor.")  
      context stop self  
    }  
    case _ => println("Executing in master")  
  }  
}
```

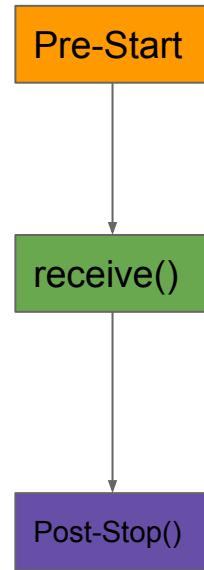
Child actors

```
def main(args : Array[String]) = {  
    val system = ActorSystem("ClusterManager")  
    // default Actor constructor  
    val masterActor = system.actorOf(Props[SparkMaster], name = "master")  
  
    masterActor tell("create-child", masterActor)  
  
    masterActor ! PoisonPill  
}
```

Stop the thread

context stop self

Life cycle of a actor



Life cycle of a actor

```
val actorSystem = ActorSystem.create()
```

```
val actor = actorSystem.actorOf(Props[LIFE_CYCLE_OF_ACTOR], name = "LIFE_CYCLE_OF_ACTOR")
```

```
actor ! "GIVE_ACTOR_A_LIFE"
```

```
//actor ! PoisonPill
```

```
actorSystem.terminate()
```

Output:

PRE-START - Called by first actor instance during startup

GIVE_ACTOR_A_LIFE

POST-STOP - Called by any actor instance during shutdown

```
class LIFE_CYCLE_OF_ACTOR extends Actor {  
  
    override def receive: Receive = {  
        case outValue => println(outValue)  
    }  
  
    override def preStart(): Unit = {  
        println("PRE-START - Called by first actor instance during startup")  
    }  
  
    override def postStop(): Unit = {  
        println("POST-STOP - Called by any actor instance during shutdown")  
    }  
}
```

```
override def preRestart(reason: Throwable, message: Option[Any]): Unit = {
```

```
    println("PRE-RESTART - Called by any running actor about to be restarted")  
}
```

```
override def postRestart(reason: Throwable): Unit = {
```

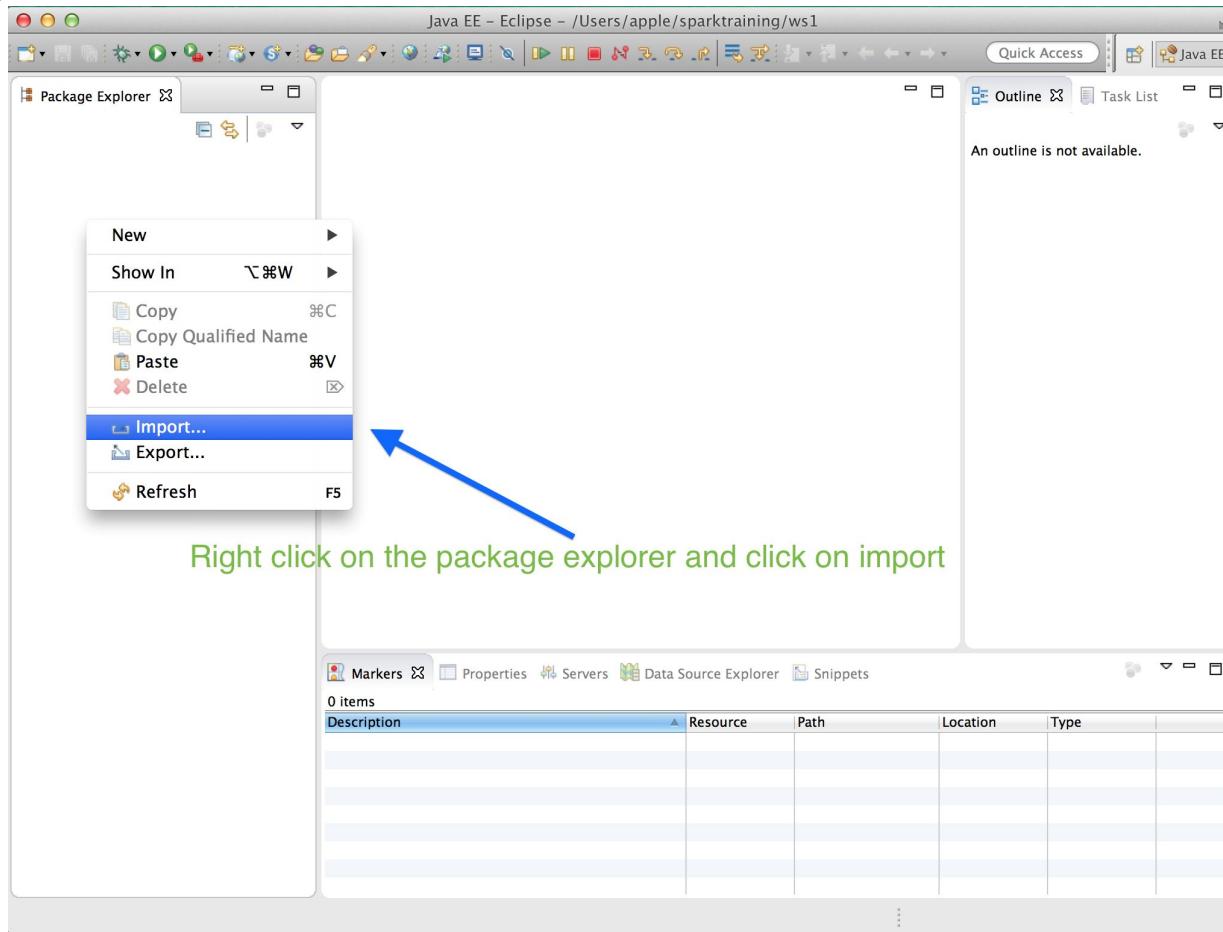
```
    println("POST-RESTART - Called on a new instance of this actor after restart")  
}
```

Importing the code using Eclipse

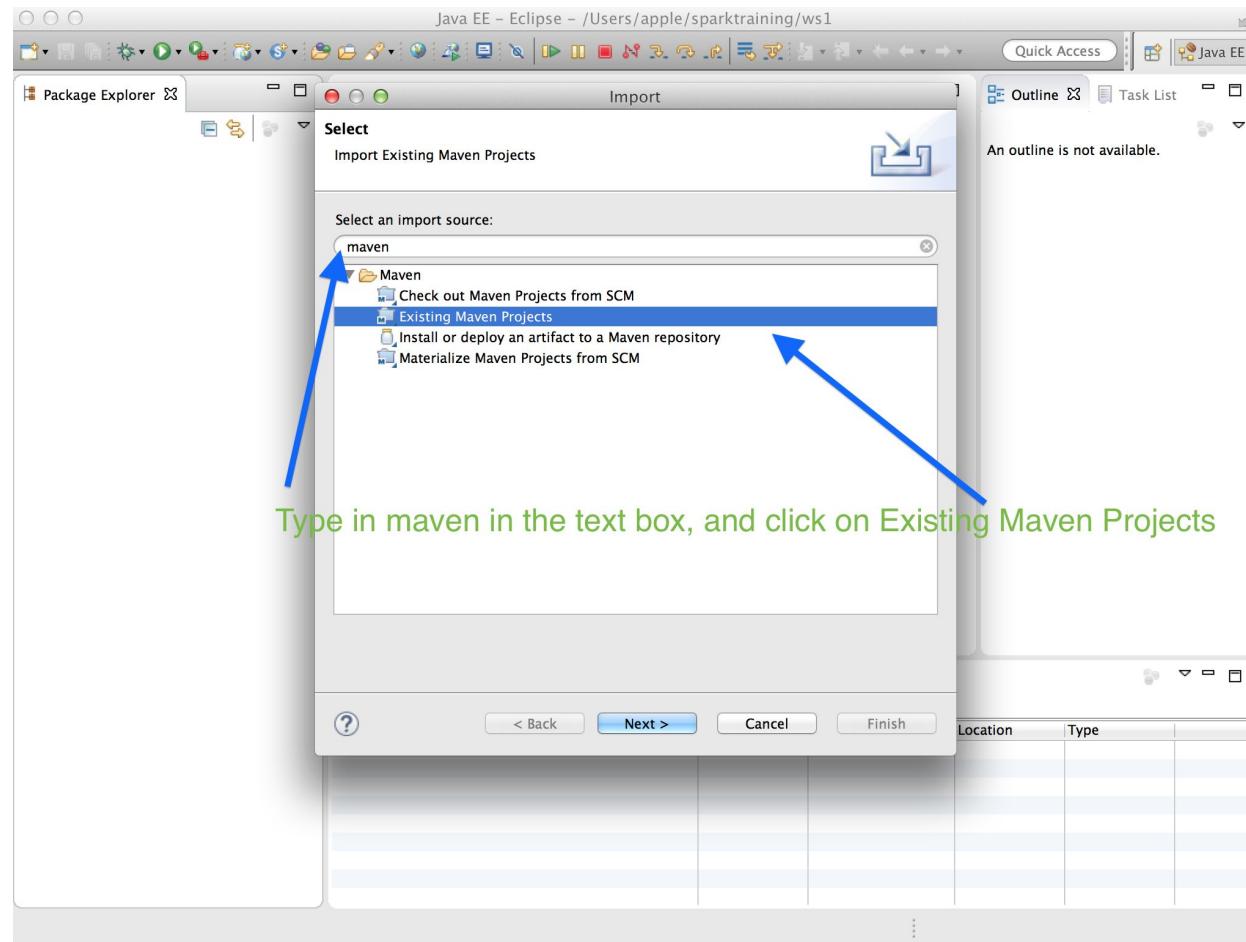
(People who are familiar, can skip this section)



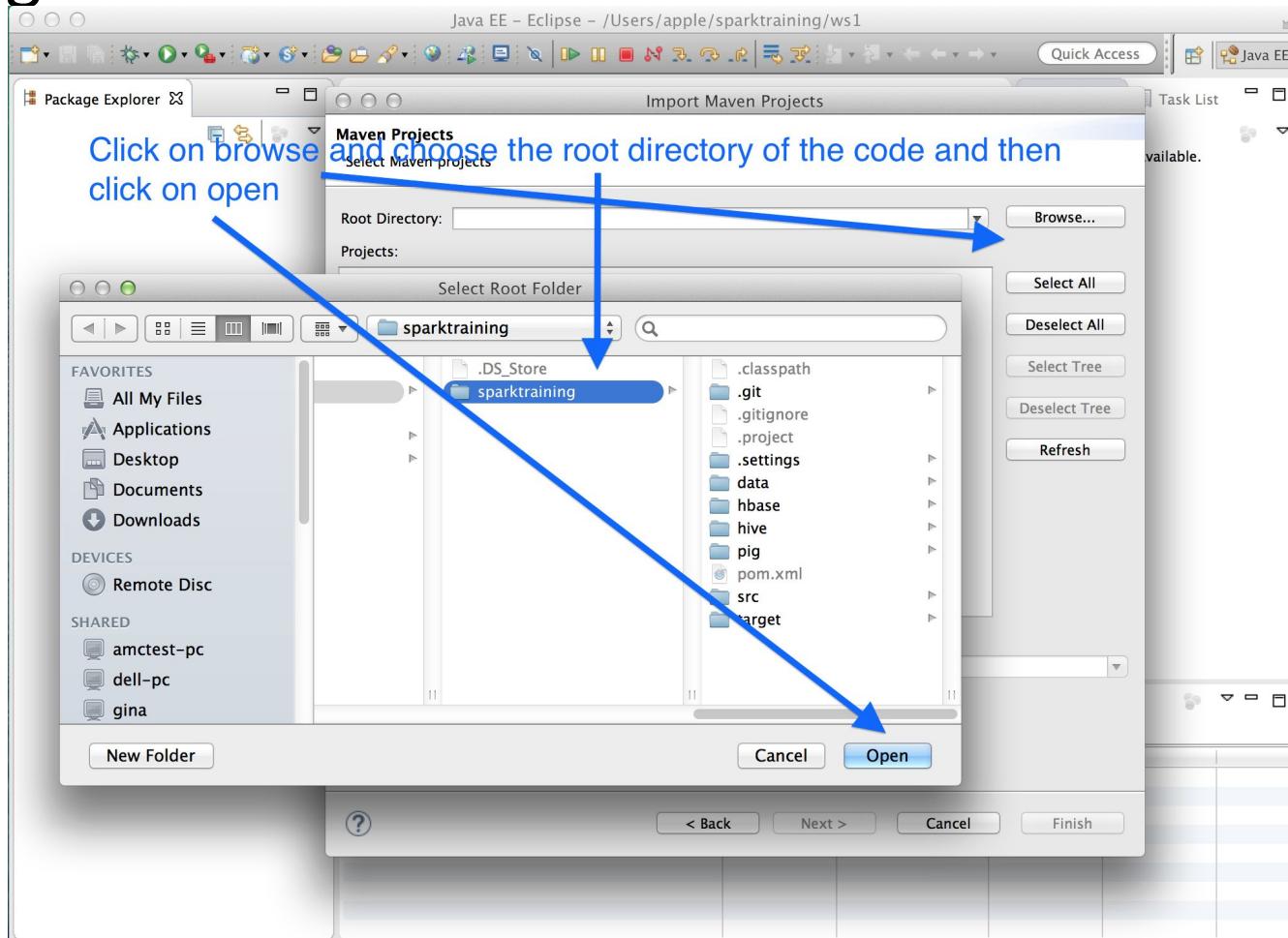
Importing the code

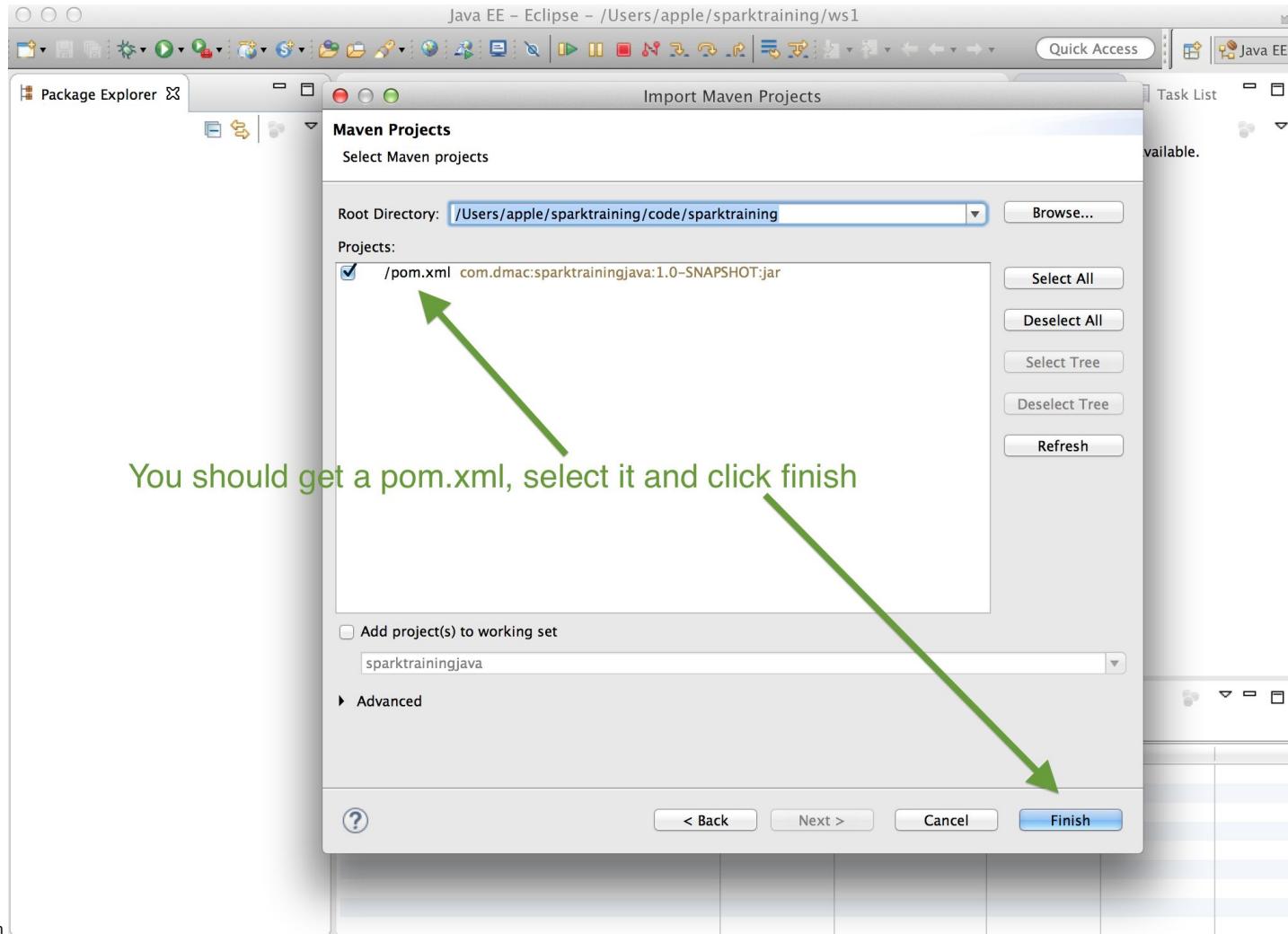


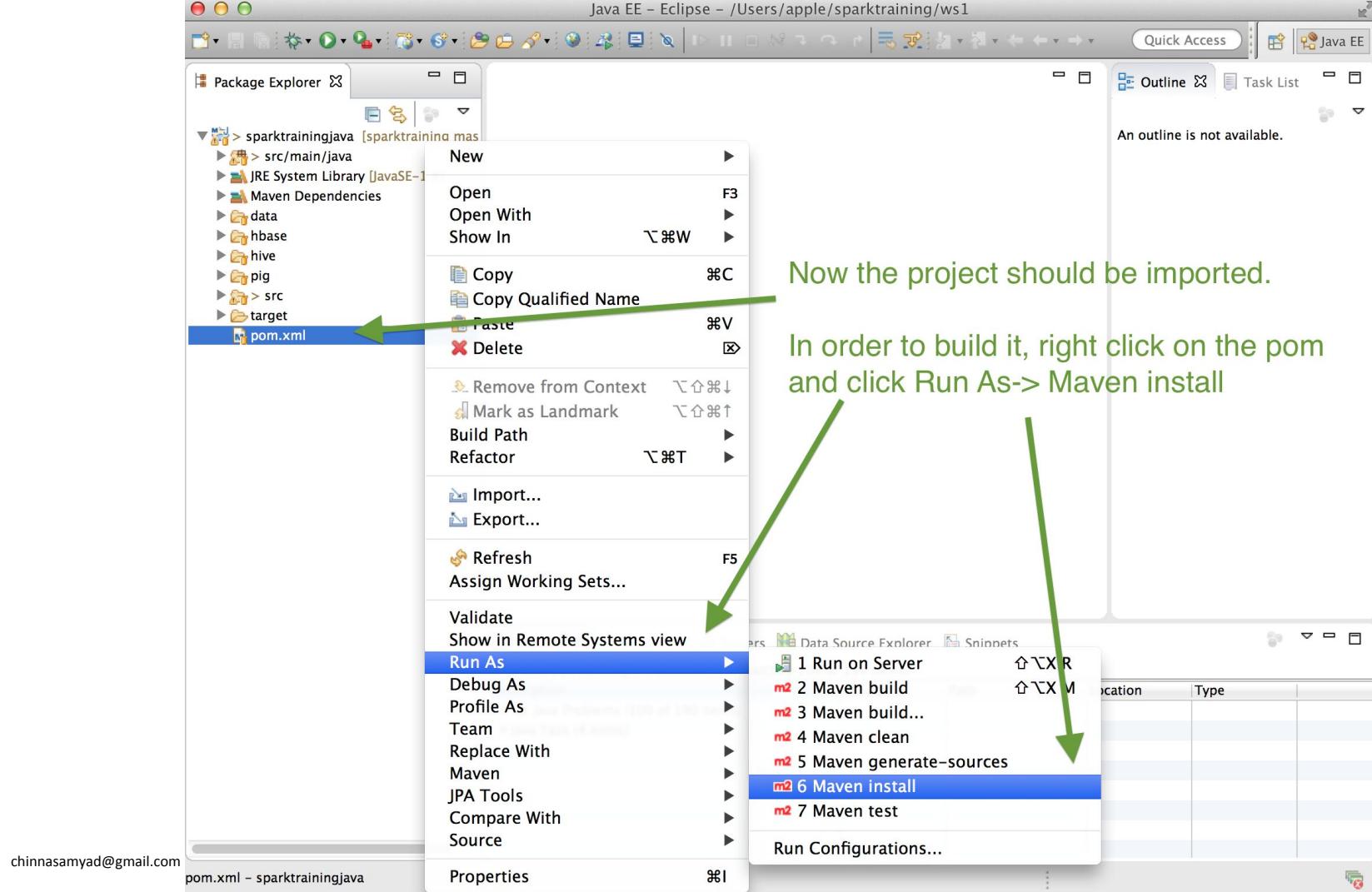
Importing the code



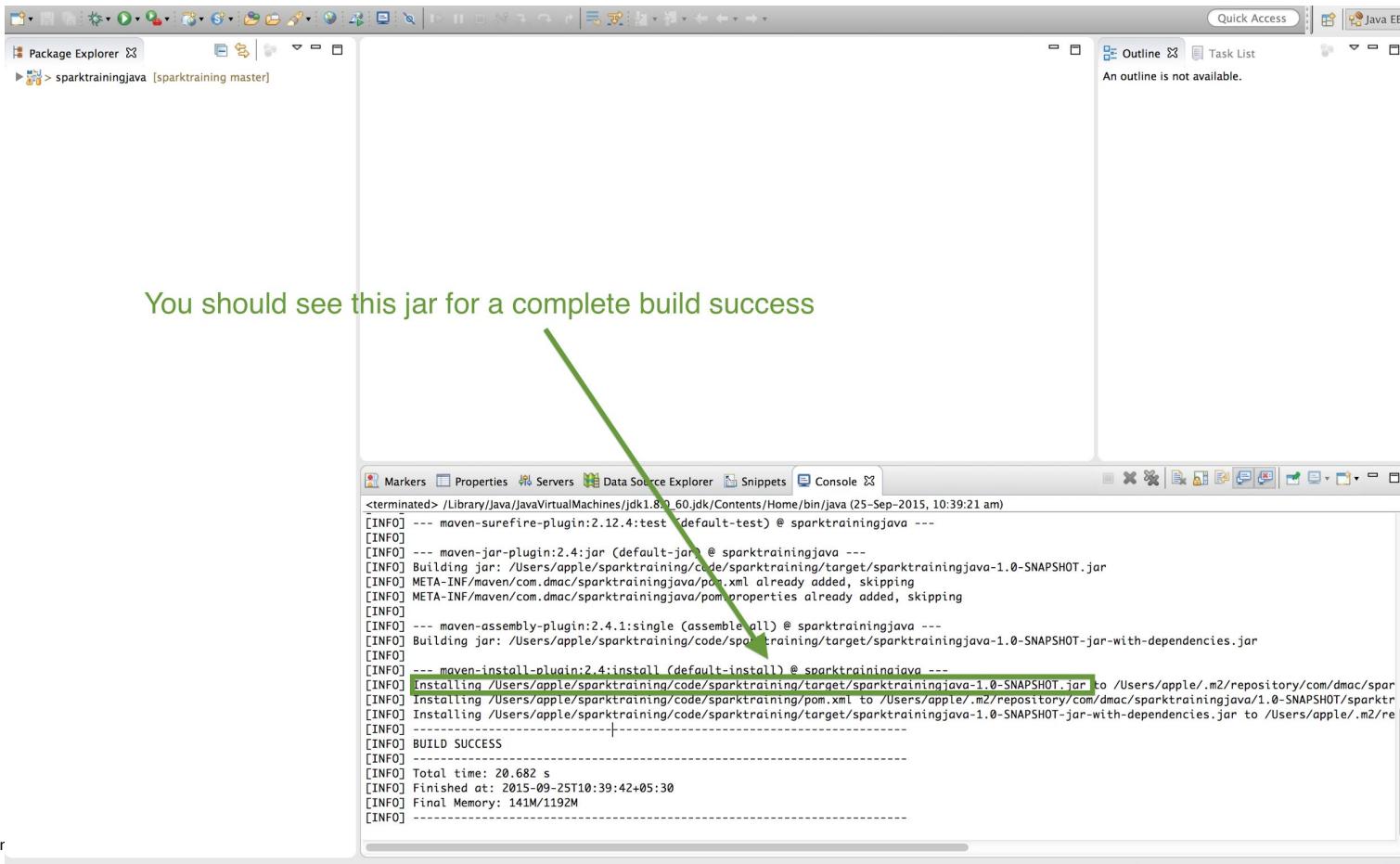
Importing the code







Importing the code

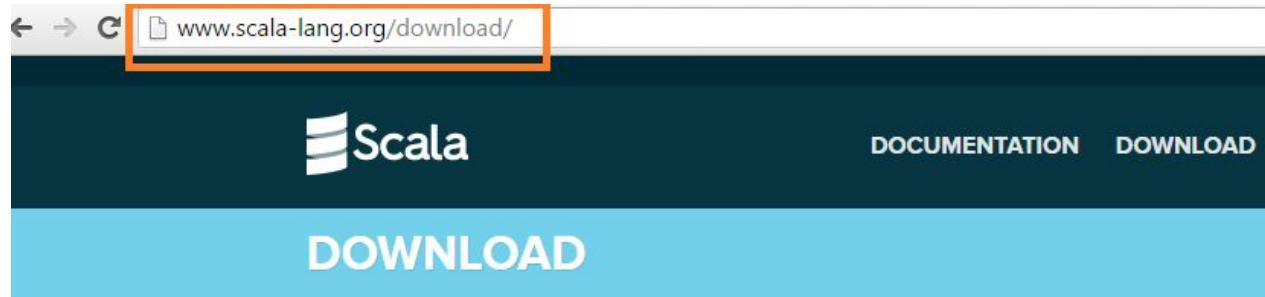


IntelliJ IDE

Scala Setup



IntelliJ - Scala Setup



The screenshot shows a web browser displaying the Scala download page at www.scala-lang.org/download/. The page has a dark header with the Scala logo and navigation links for DOCUMENTATION and DOWNLOAD. A large blue "DOWNLOAD" button is prominent. The URL bar at the top is highlighted with an orange box.

Choose one of three ways to get started with Scala!



Download Scala 2.11.7 binaries for your system ([All downloads](#)).



[Need help installing?](#)

Or



Get started with Typesafe Activator

Typesafe Activator is a browser-based or command-line tool that helps developers get started with Scala.

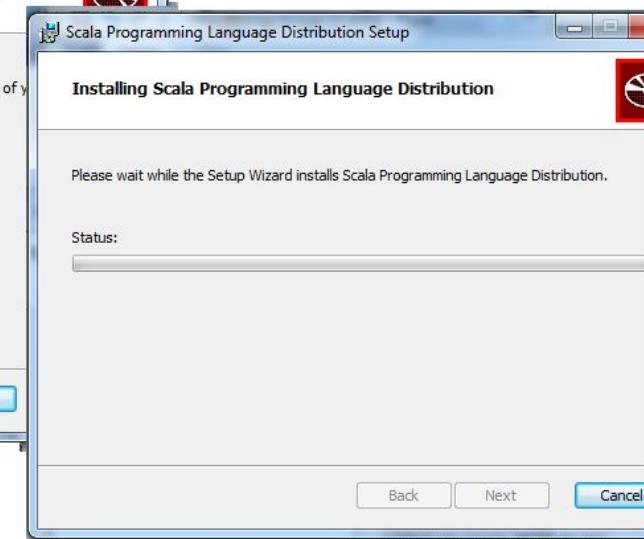
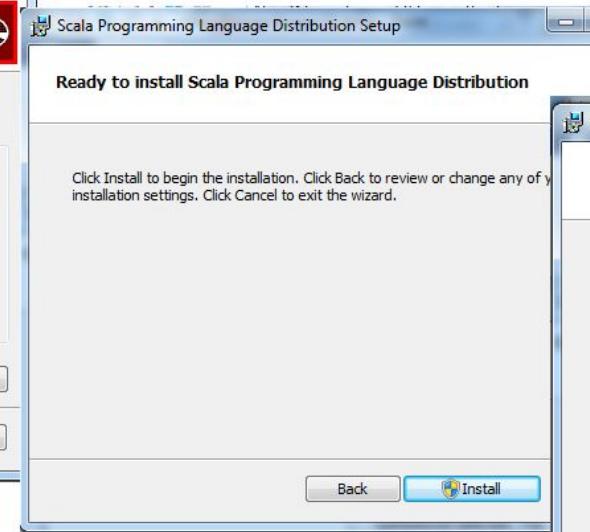
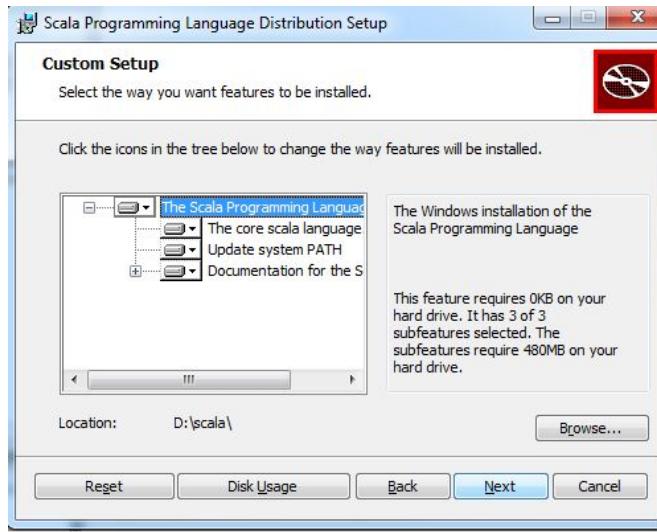


[Need help installing?](#)

IntelliJ - Scala Setup



IntelliJ - Scala Setup

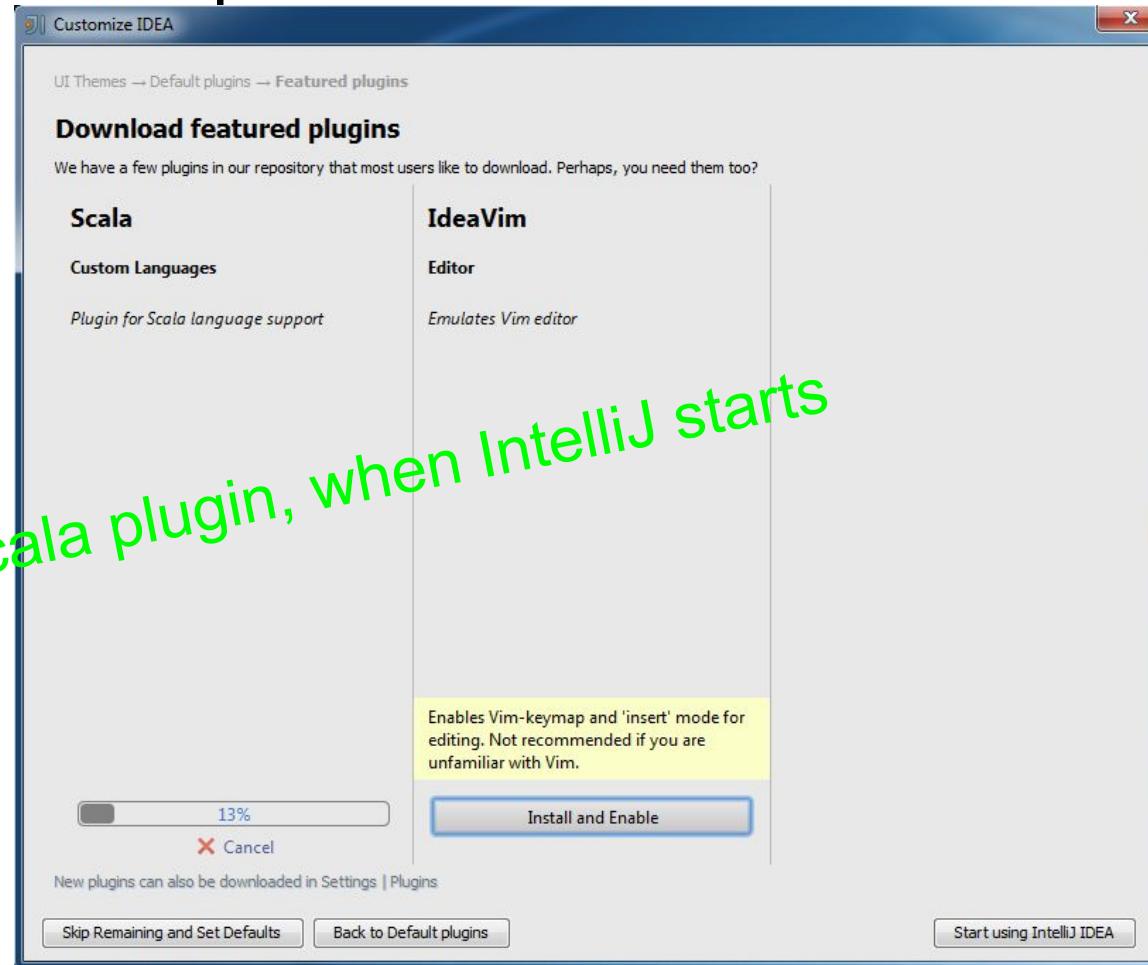


IntelliJ - Scala Setup

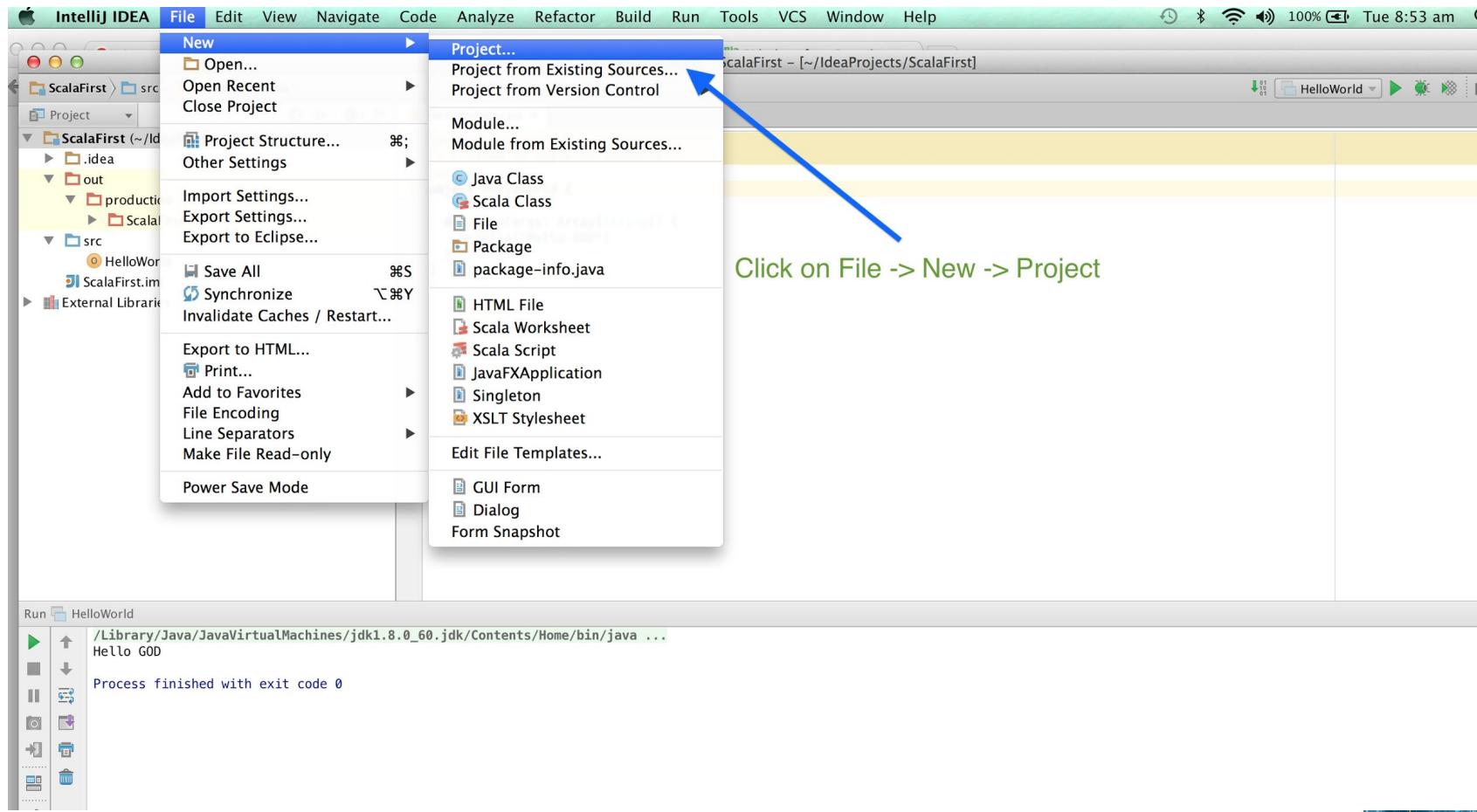


IntelliJ - Scala Setup

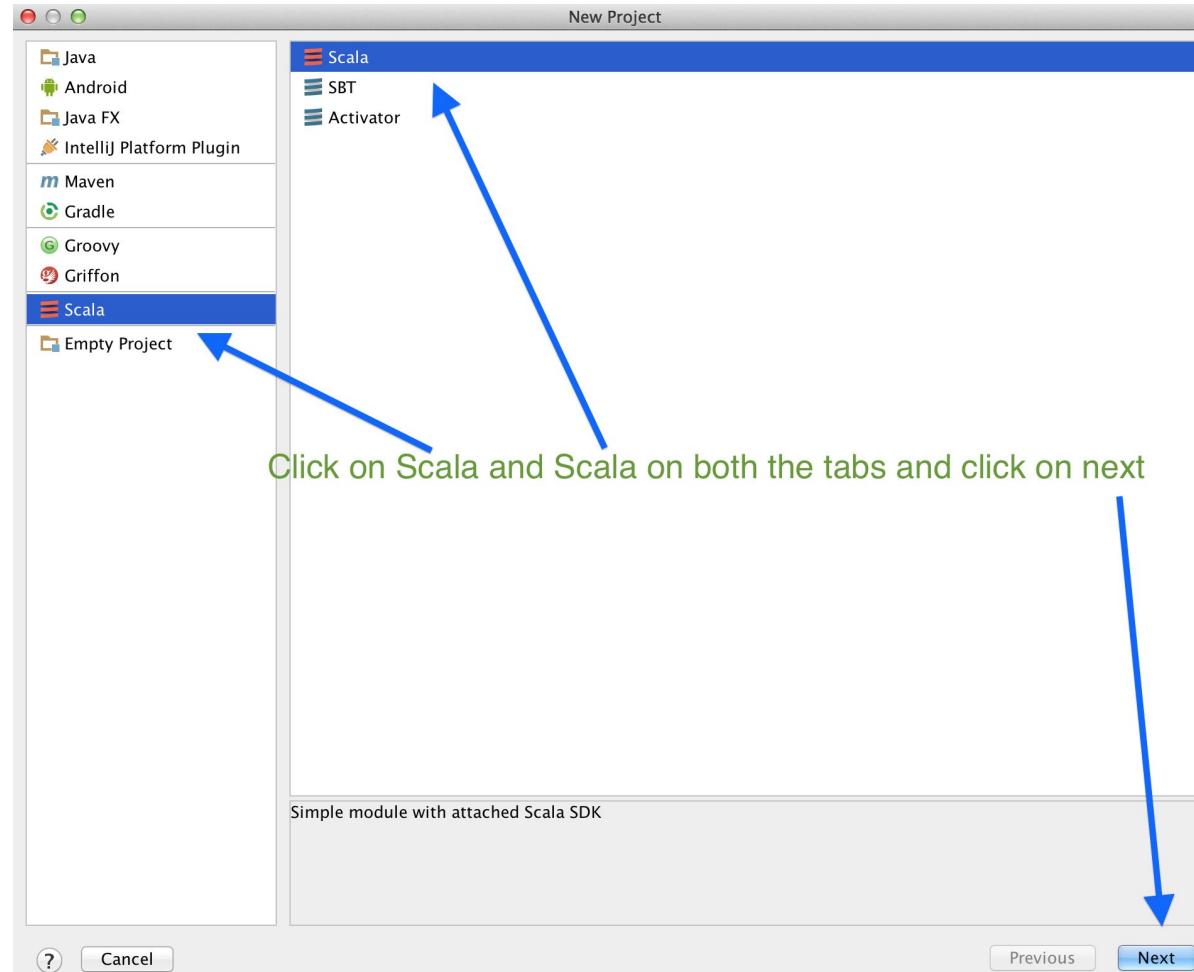
Install the scala plugin, when IntelliJ starts first



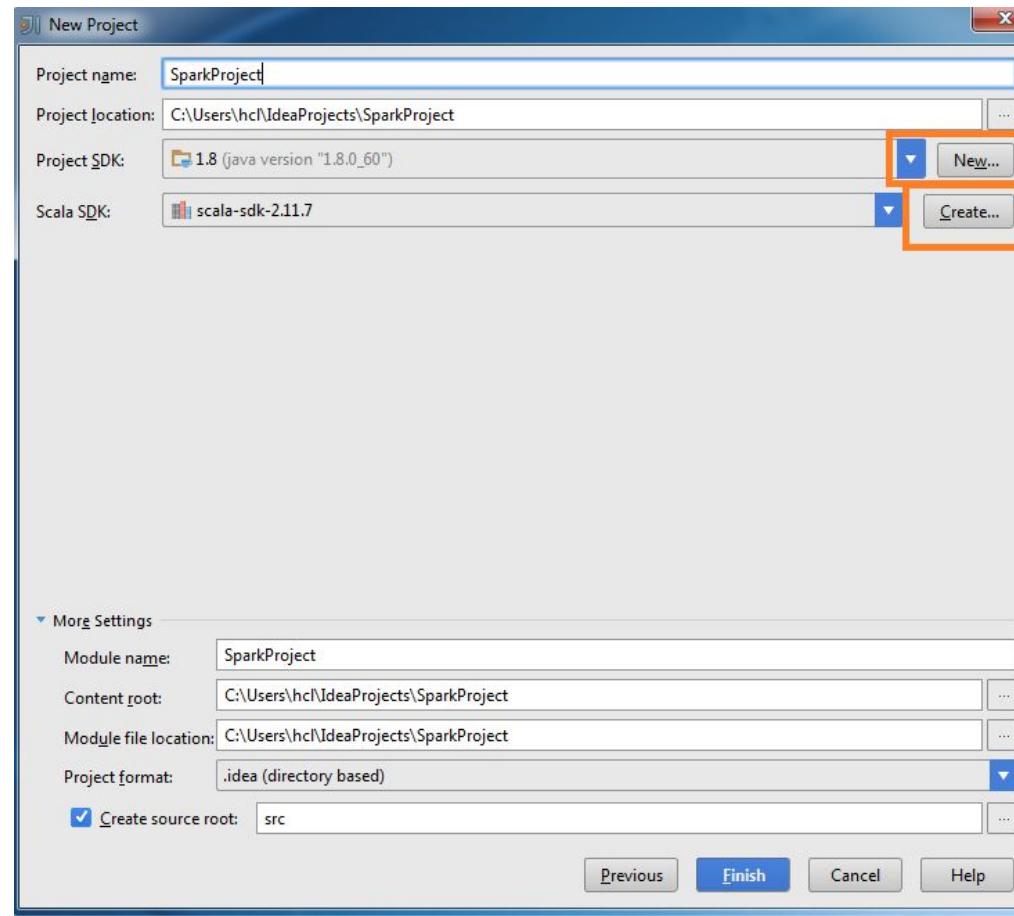
IntelliJ - Scala Setup



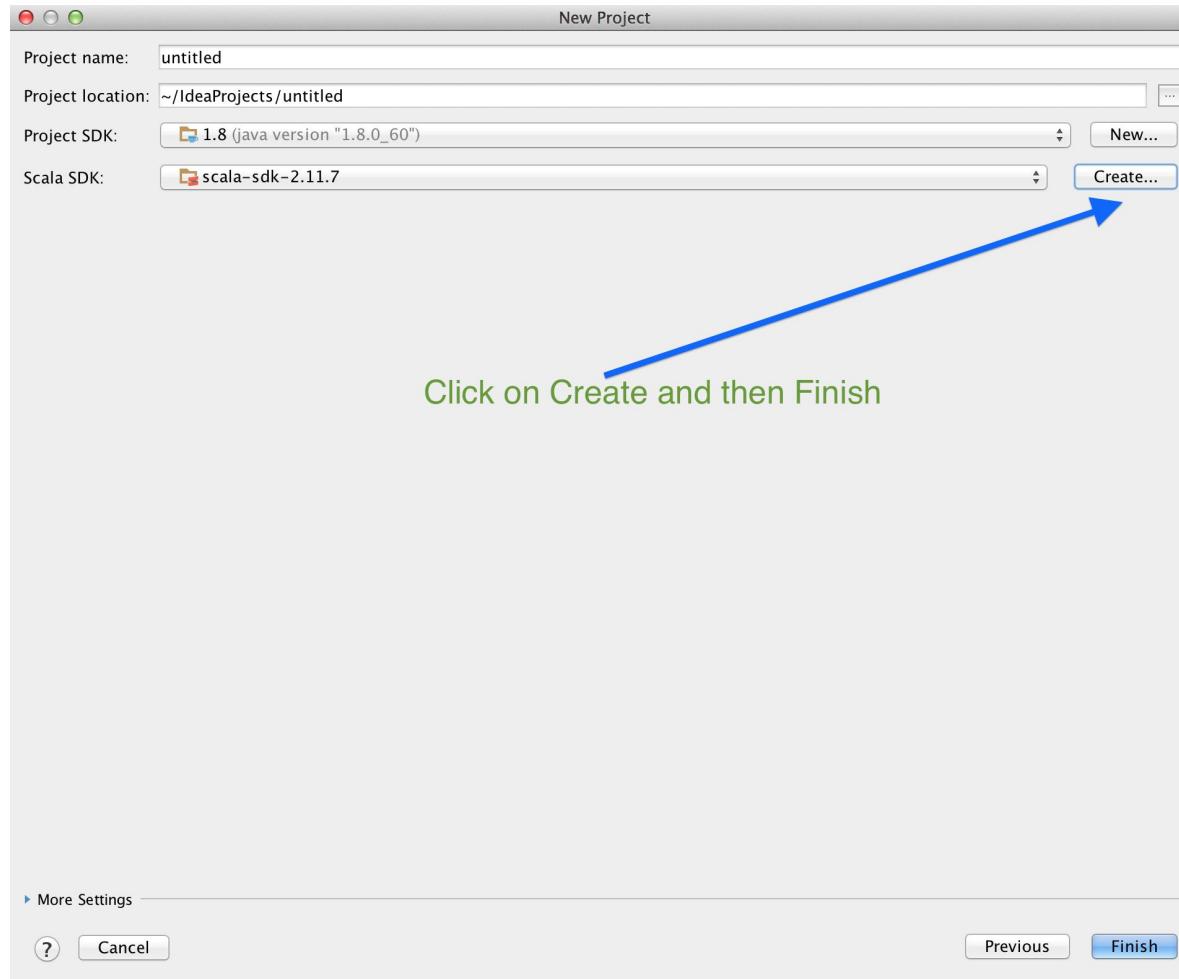
IntelliJ - Scala Setup



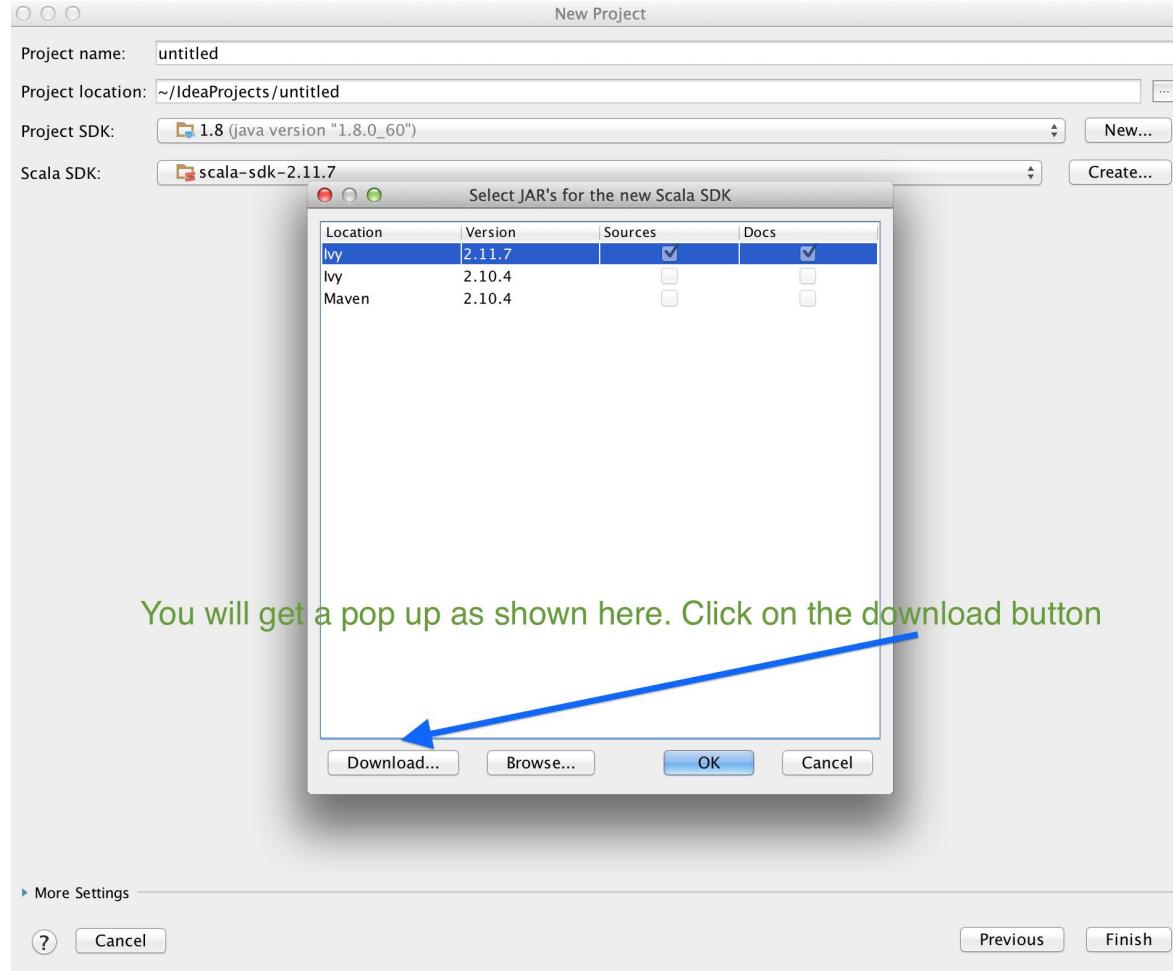
IntelliJ - Scala Setup



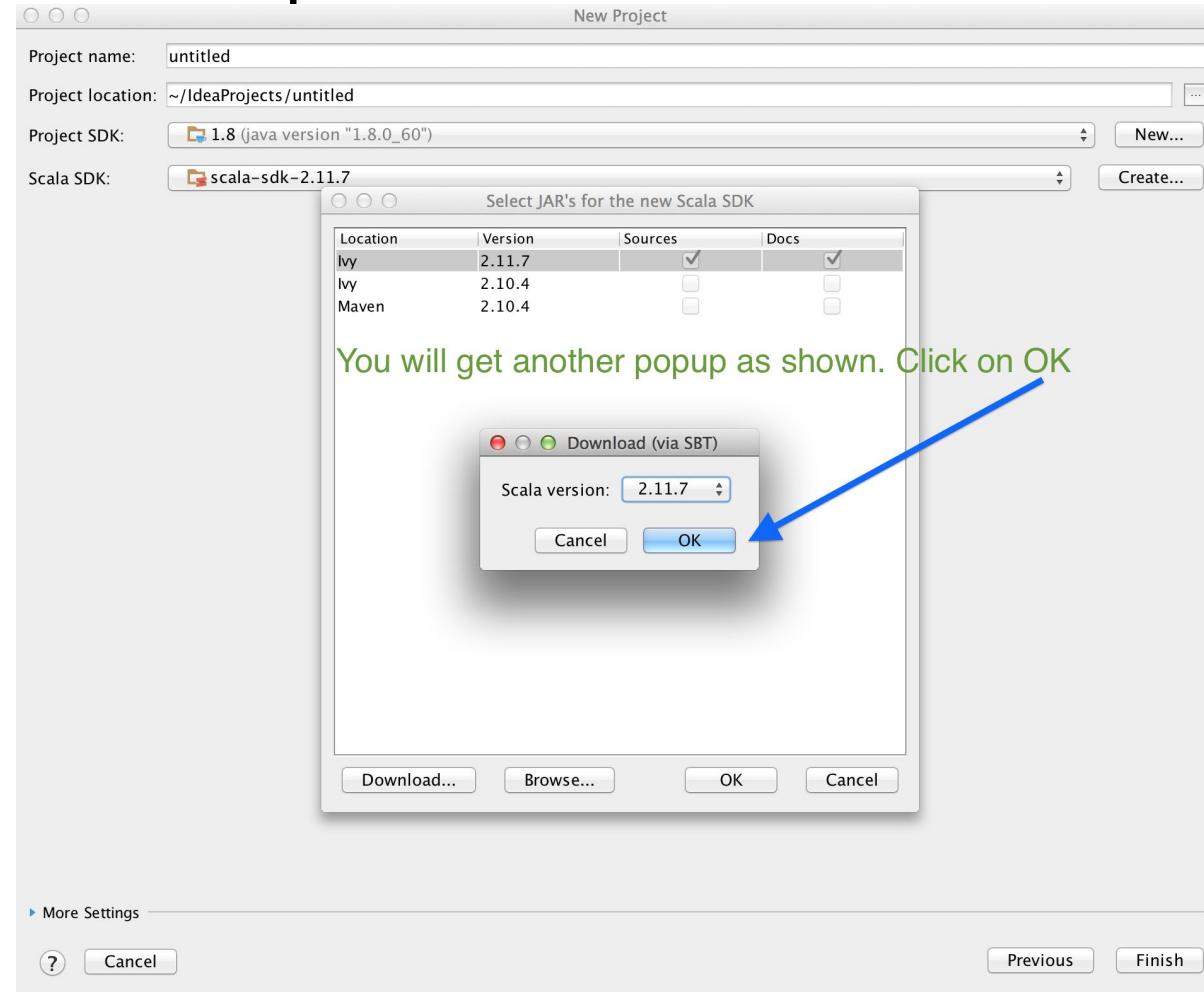
IntelliJ - Scala Setup



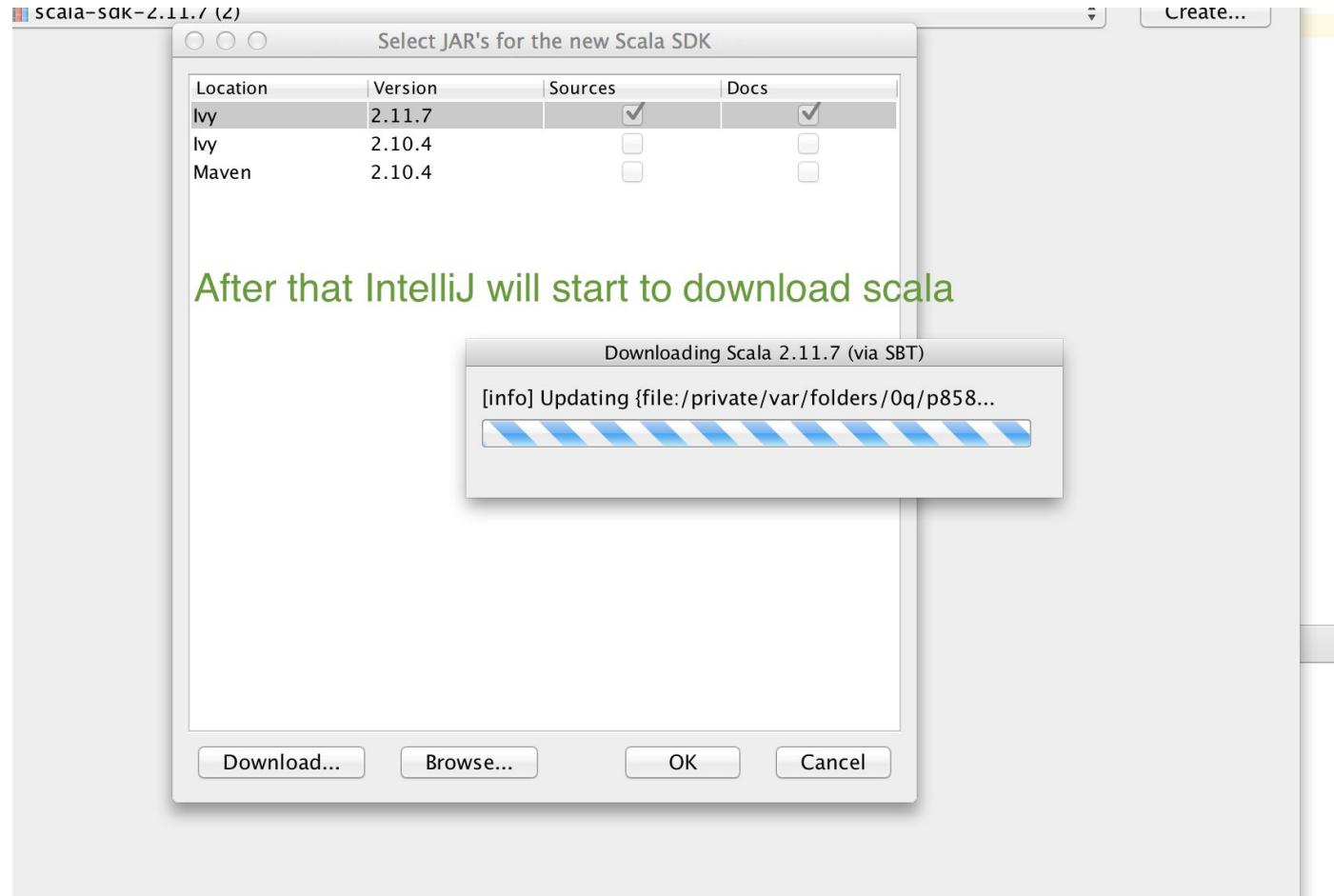
IntelliJ - Scala Setup



IntelliJ - Scala Setup



IntelliJ - Scala Setup



IntelliJ - Scala Setup

The screenshot shows a Google Chrome window displaying the Scala plugin download page from the JetBrains Plugin Repository. The URL is <https://plugins.jetbrains.com/idea/plugin/1347-scala>. The page title is "Scala for IntelliJ IDEA :: JetBrains Plugin Repository". The main content is a table titled "Download plugin" showing versions, compatible builds, update dates, and download links. A "Stable" tab is selected. Below the table is a "PREVIOUS UPDATES" button. At the bottom, there is a "GENERAL USAGE INSTRUCTIONS" section and a "Show all" link.

VERSION	COMPATIBLE BUILDS	UPDATE DATE	DOWNLOAD
2017.1.8	171.1834.1–172	03.02.2017	DOWNLOAD
2016.3.8	163.4396–164	24.01.2017	DOWNLOAD
2016.3.7	163.4396–164	20.01.2017	DOWNLOAD
2017.1.6	171.1834.1–172	11.01.2017	DOWNLOAD
2016.3.6	163.4396–164	09.01.2017	DOWNLOAD
2017.1.5	171.1834.1–172	22.12.2016	DOWNLOAD
2016.3.5	163.4396–164	12.12.2016	DOWNLOAD
2016.3.4	163.4396–164	01.12.2016	DOWNLOAD
2016.3.3	163.4396–164	21.11.2016	DOWNLOAD
2016.3.2	163.4396–164	27.09.2016	DOWNLOAD

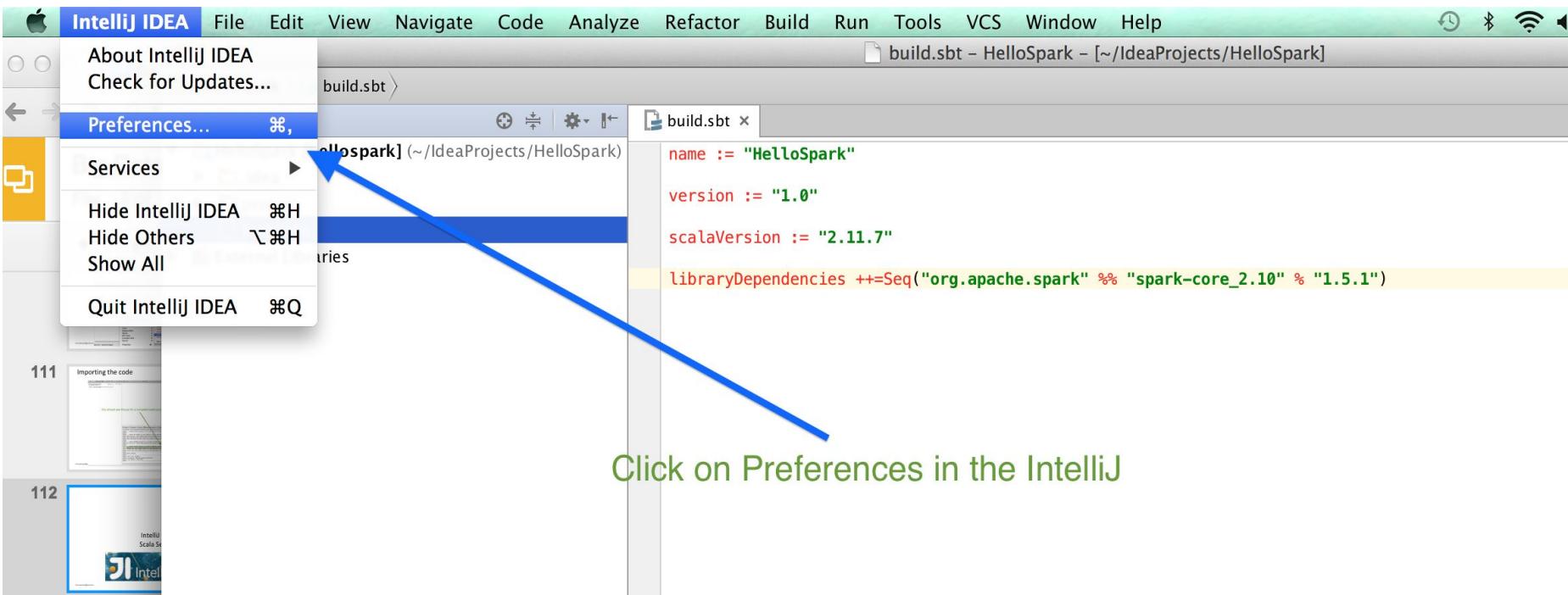
You can also download the scala plugin from and install it manually in the IntelliJ,

<https://plugins.jetbrains.com/idea/plugin/1347-scala>

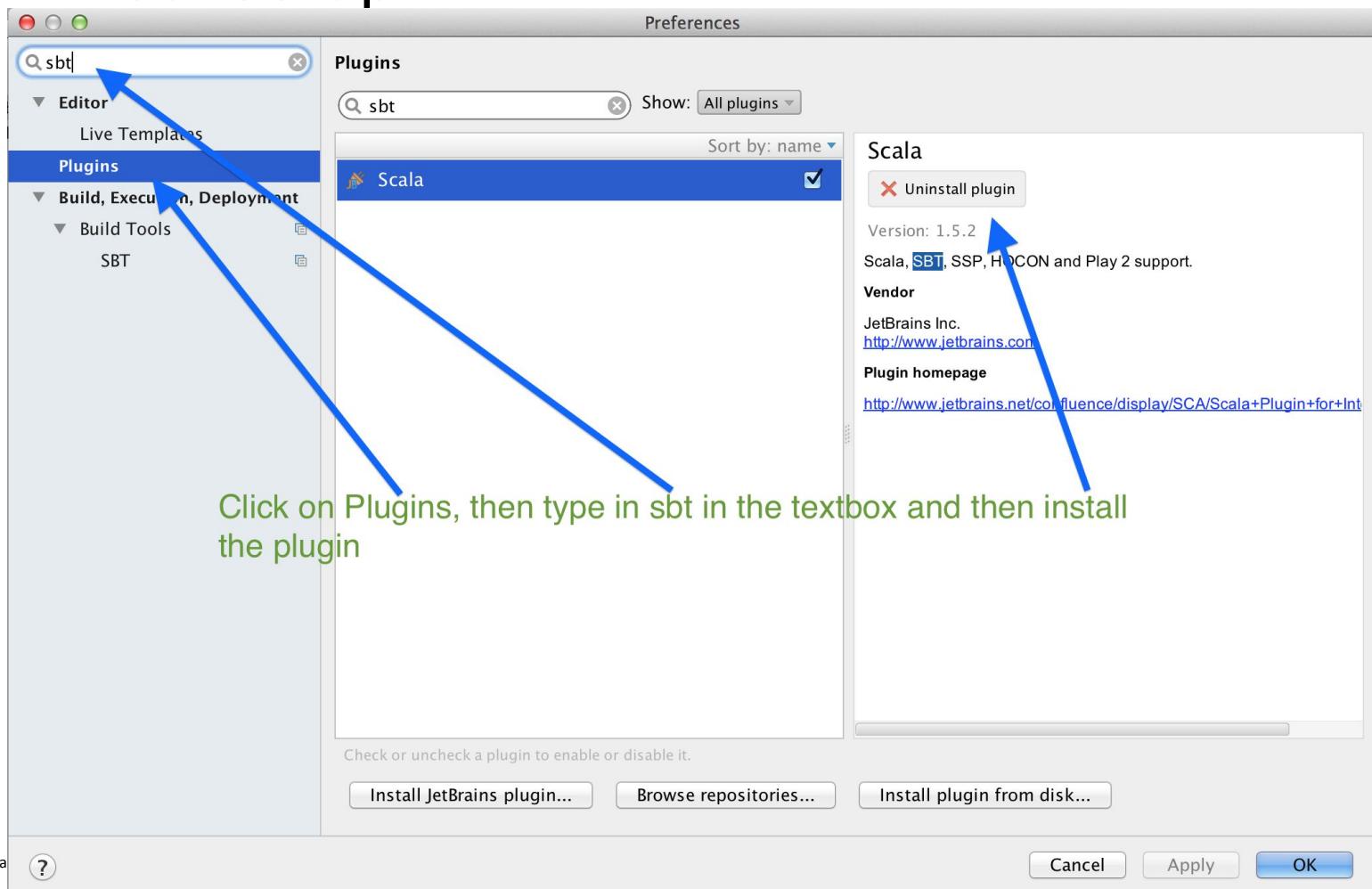
IntelliJ IDE sbt Setup



IntelliJ - sbt Setup



IntelliJ - sbt Setup

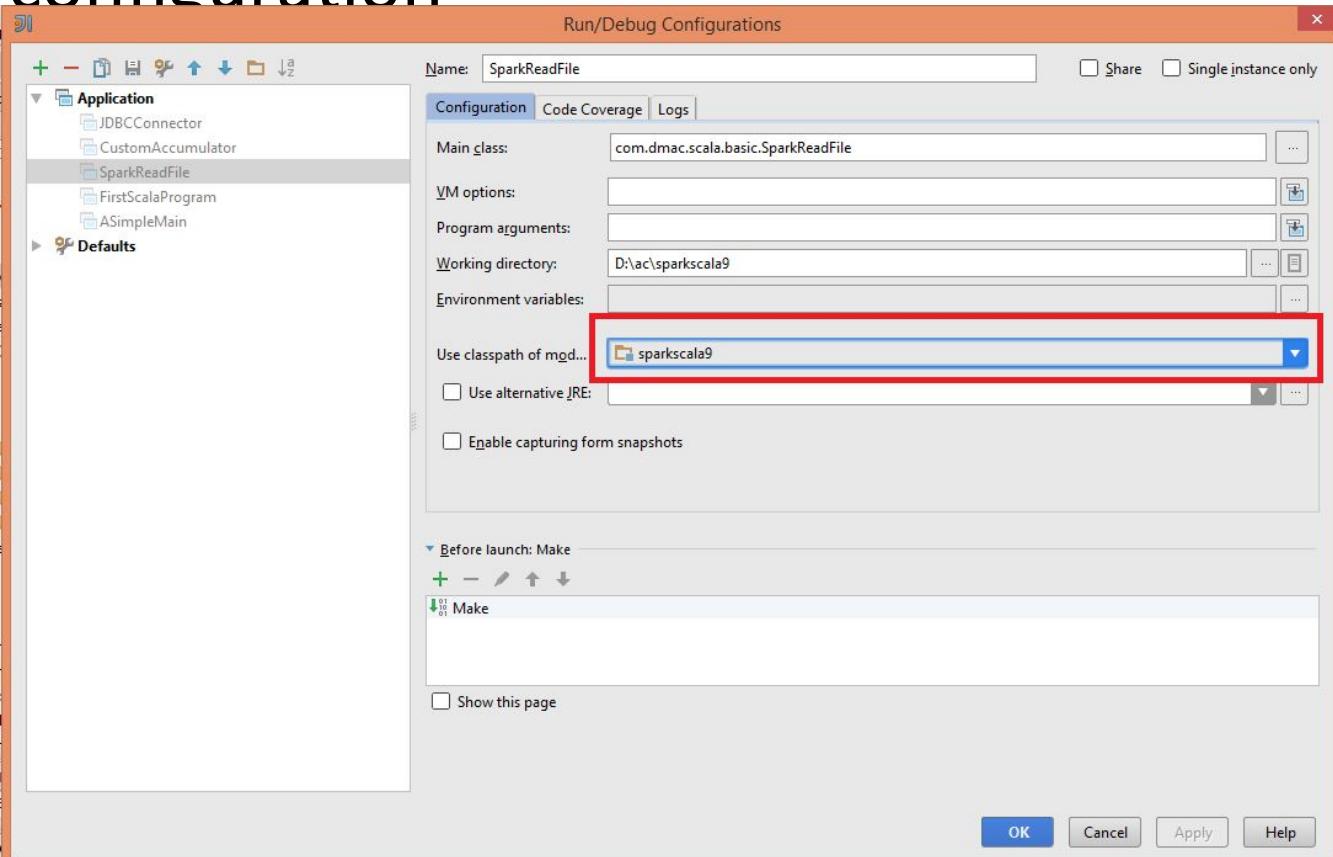


IntelliJ IDE

Correctness Check



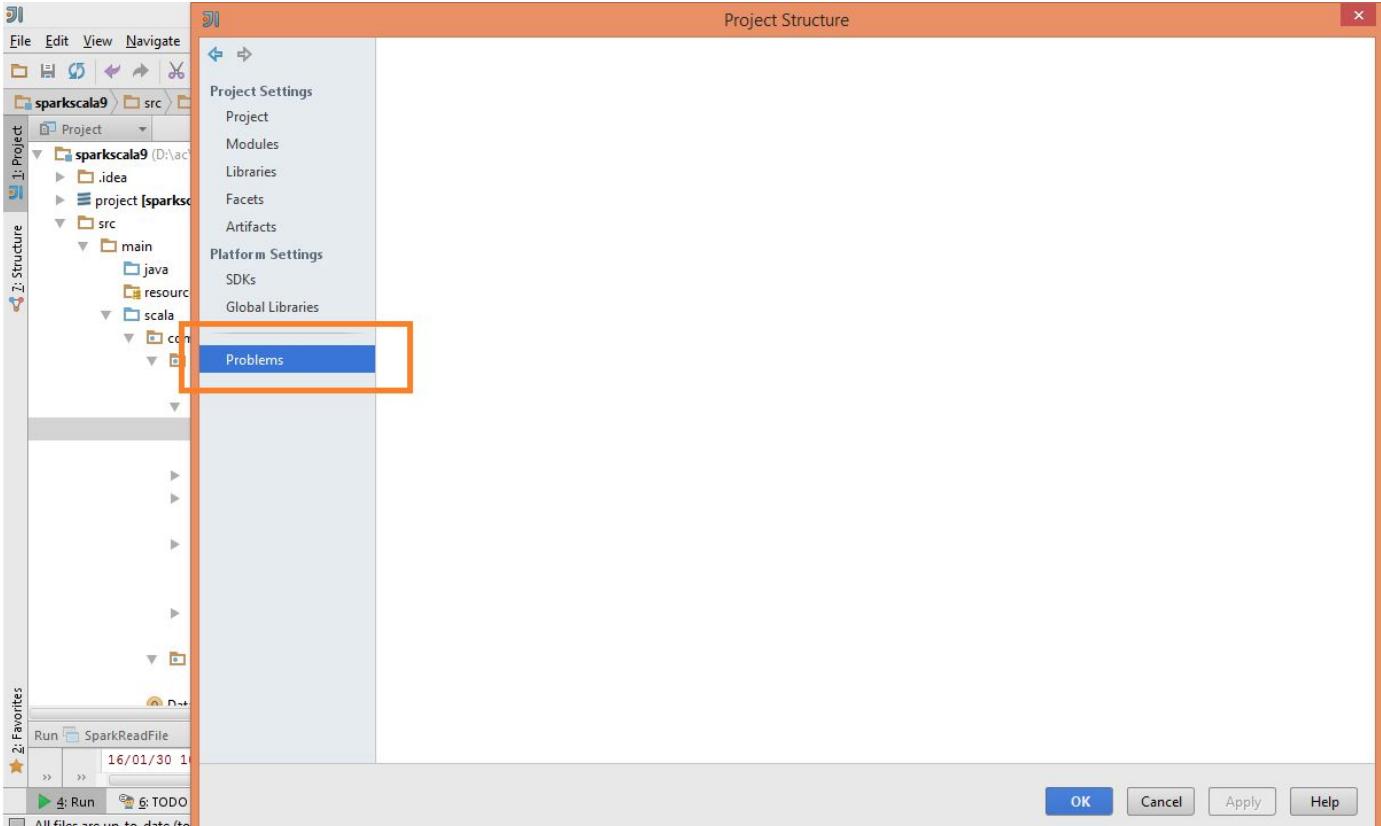
IntelliJ - Check configuration



Goto Run->
Edit Configurations

use classpath....
should contain your project

IntelliJ - Check configuration



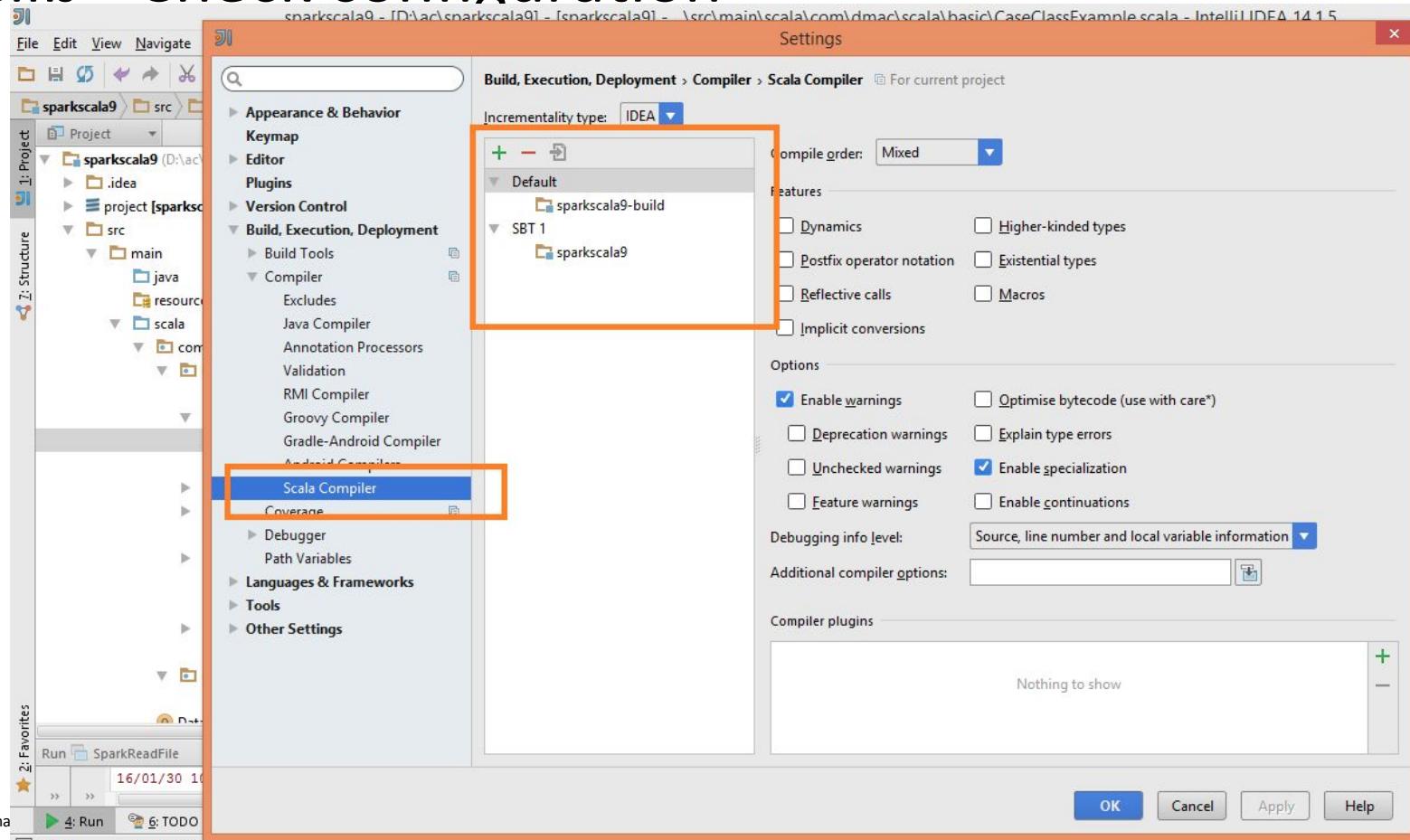
Goto File>
Project Structure

Problems should not contain any entry

chinna.samyad@gmail.com

IntelliJ - Check configuration

File -> Settings

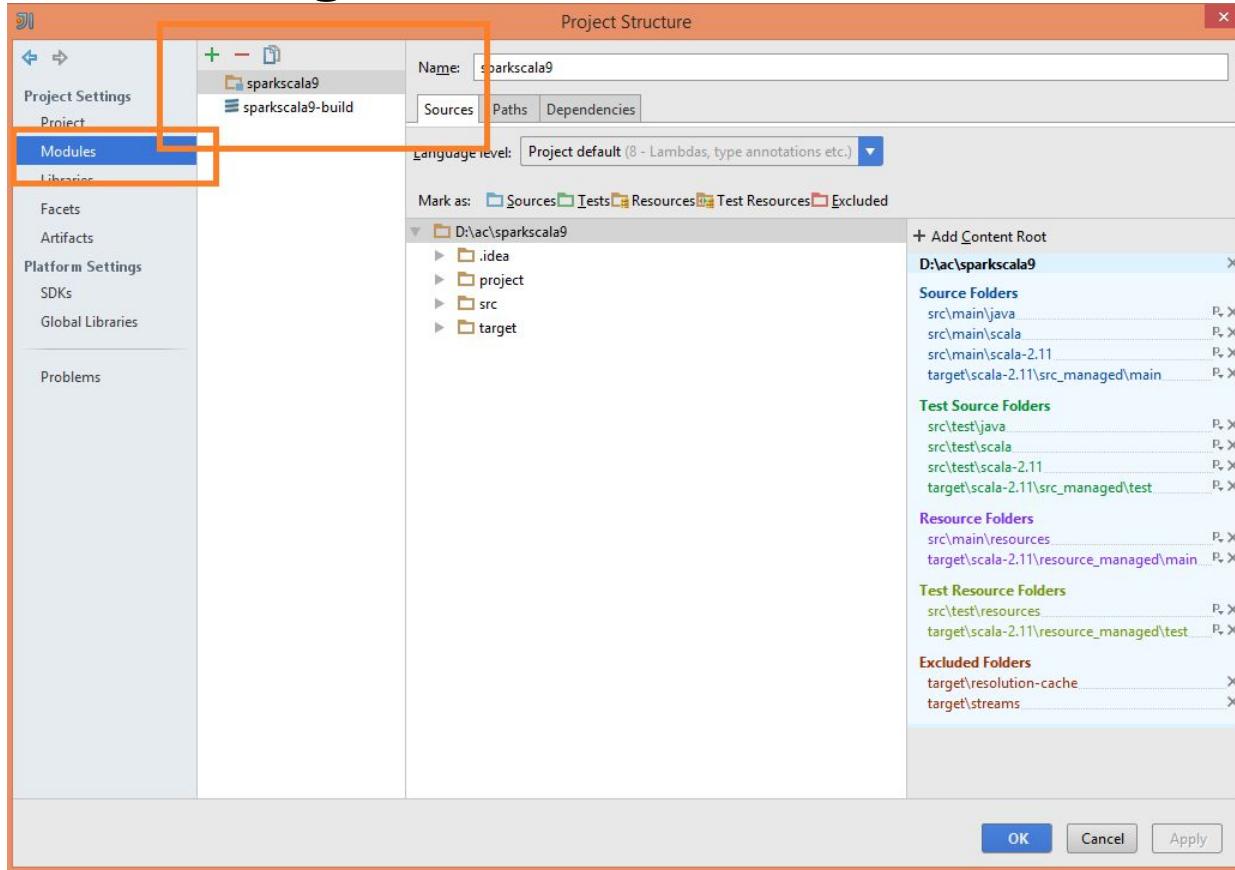


chinnasamyad@gmail.com

IntelliJ 14.1.5

IntelliJ - Check configuration

File -> Project
Structure

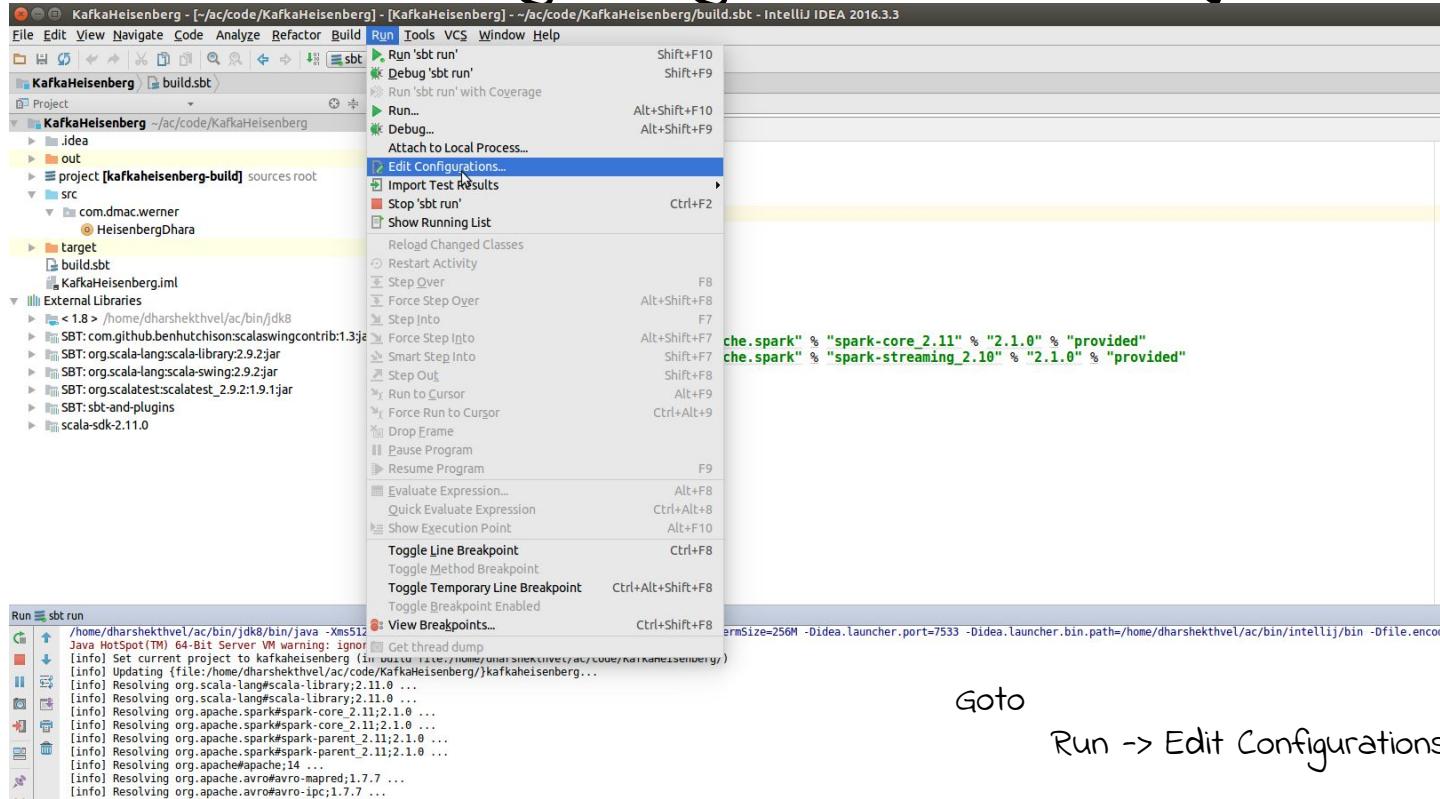


IntelliJ IDE

Integrating sbt with IntelliJ



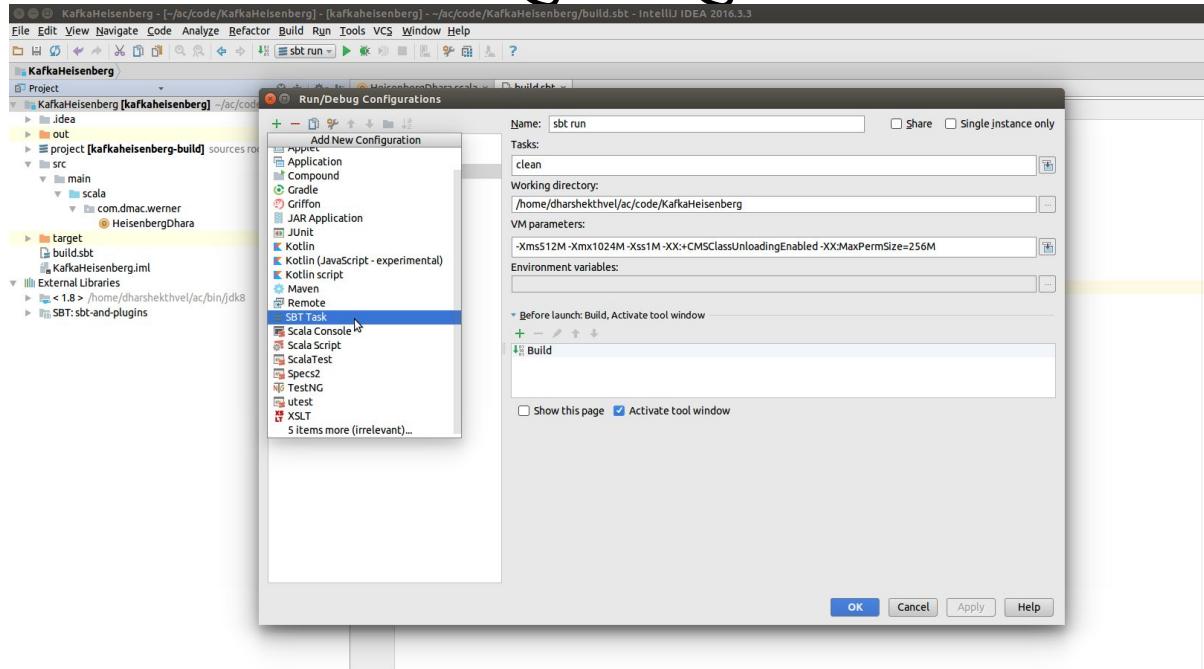
IntelliJ IDE - Integrating sbt with IntelliJ



Goto

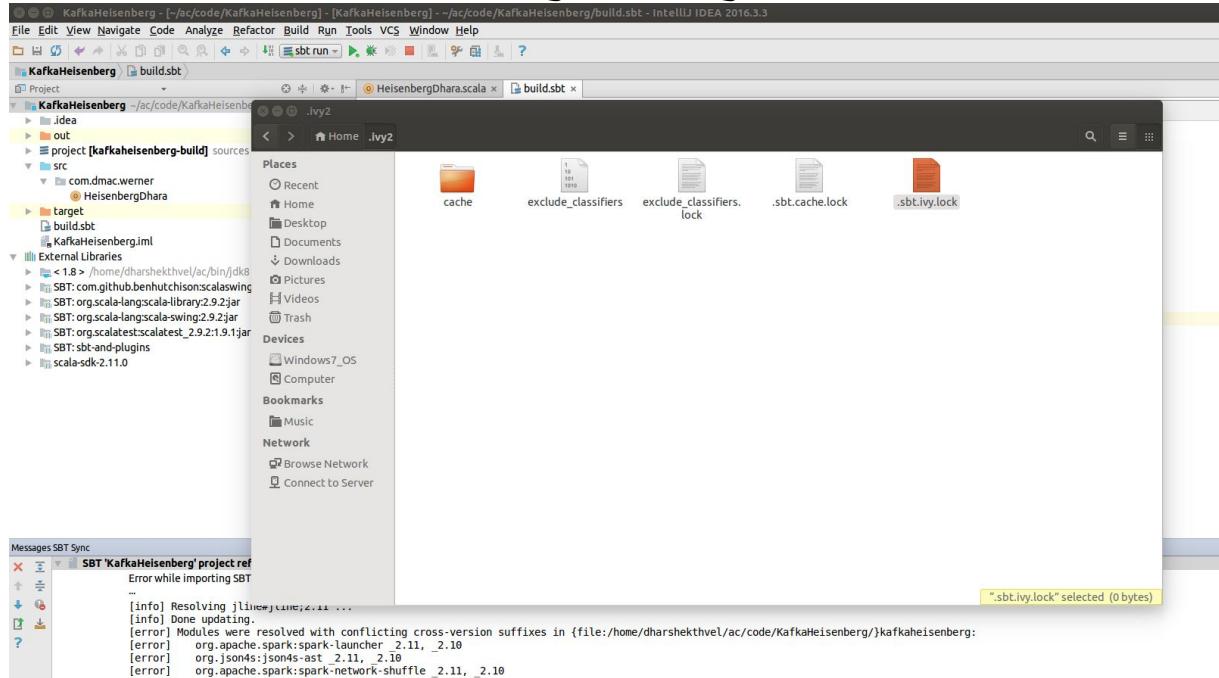
Run -> Edit Configurations

IntelliJ IDE - Integrating sbt with IntelliJ



In the Run/Debug Configurations dialog, click on the + and choose SBT Task. Give a good name to it and give package as the task.

IntelliJ IDE - Integrating sbt with IntelliJ



If you are getting a acquire to lock... error, then delete the `sbt.ivy.lock` file in the home `.ivy2` directory. `.ivy2` directory will be hidden.

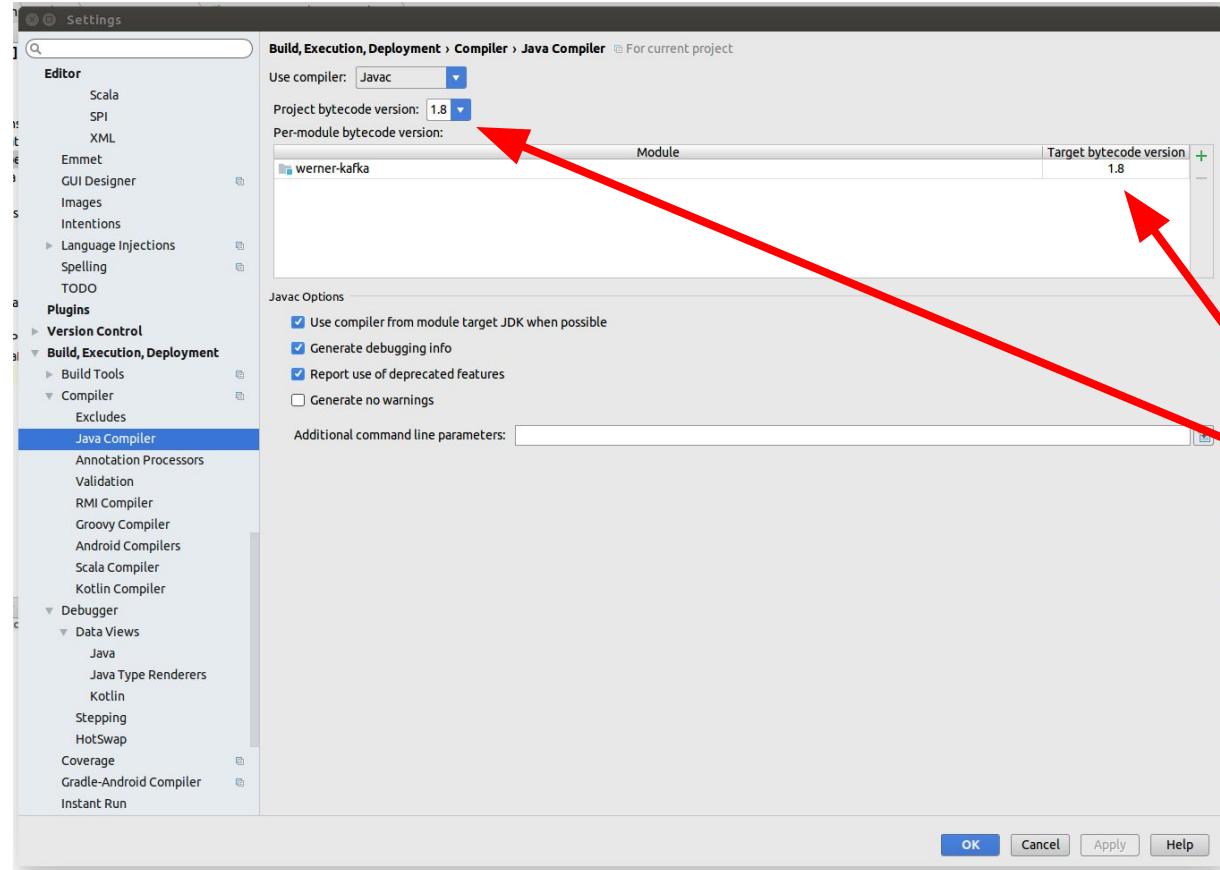
IntelliJ IDE

Byte Code not supported at this level



IntelliJ IDE

Byte Code not supported at this level

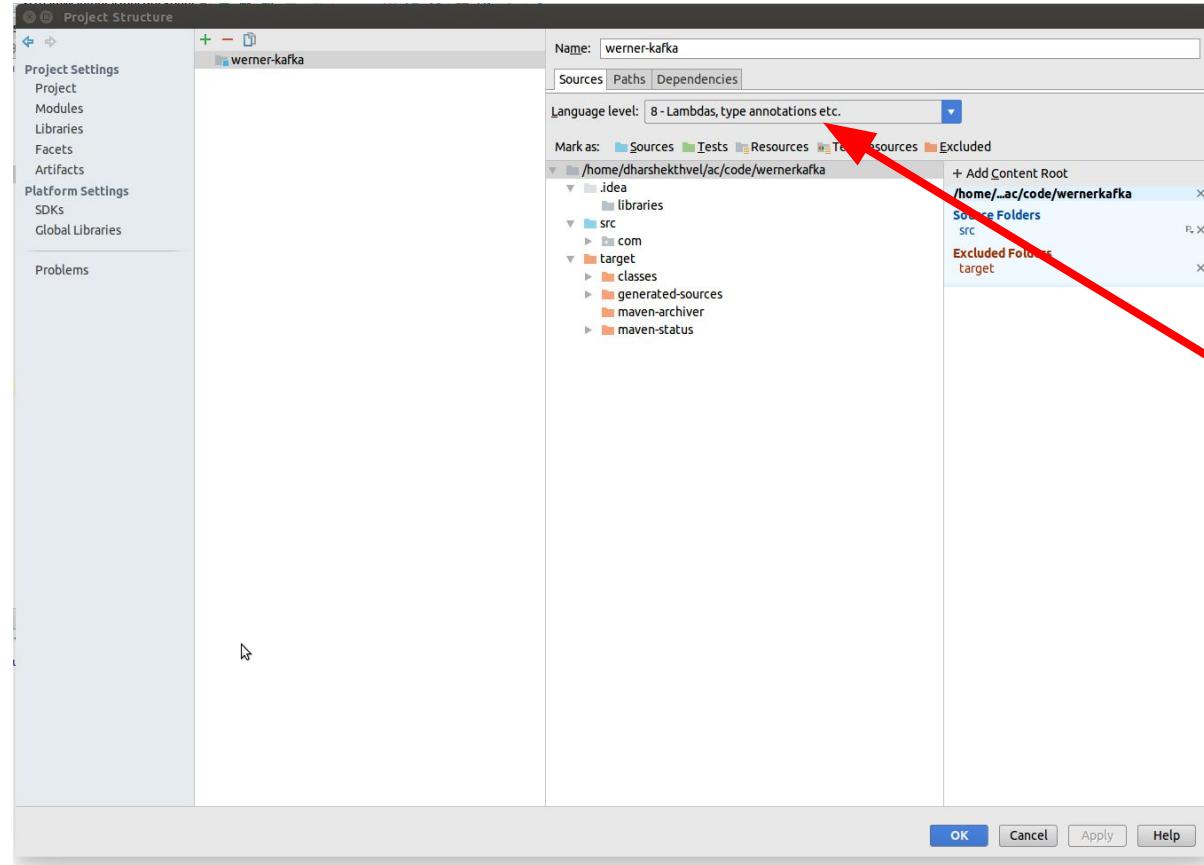


Ensure that you
have done 1.8

IntelliJ IDE

Byte Code not supported at this level

File → Project Structure → modules

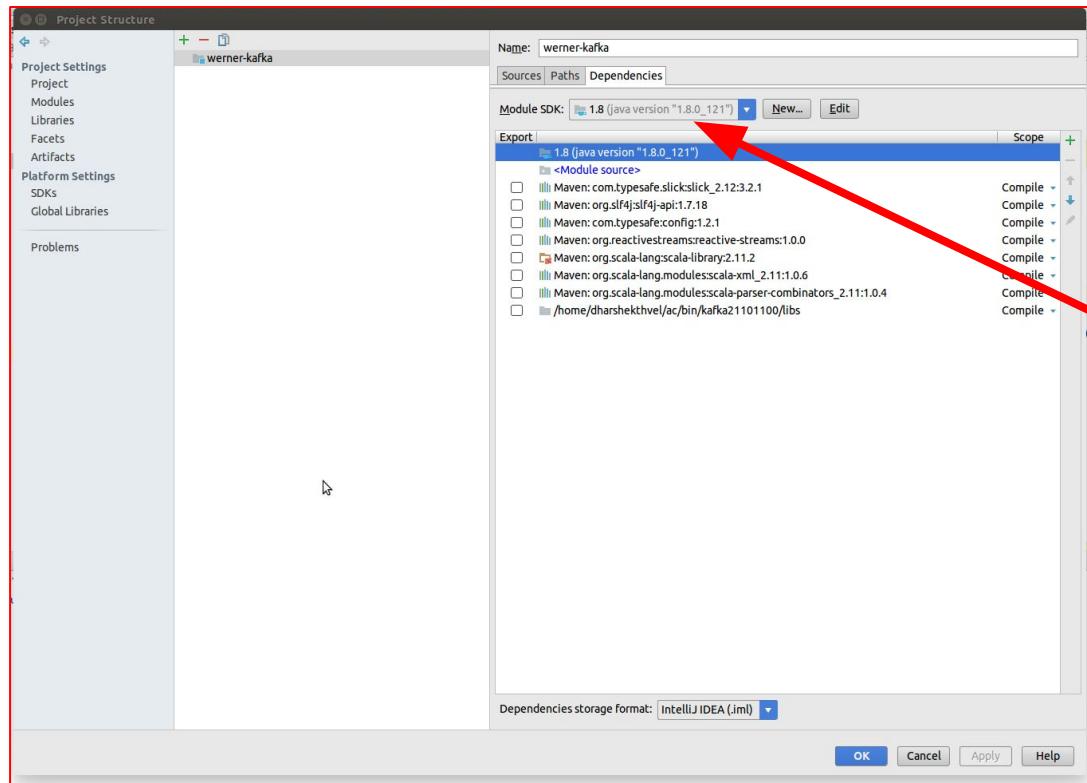


Ensure that you
have done 1.8

IntelliJ IDE

Byte Code not supported at this level

File → Project Structure → modules

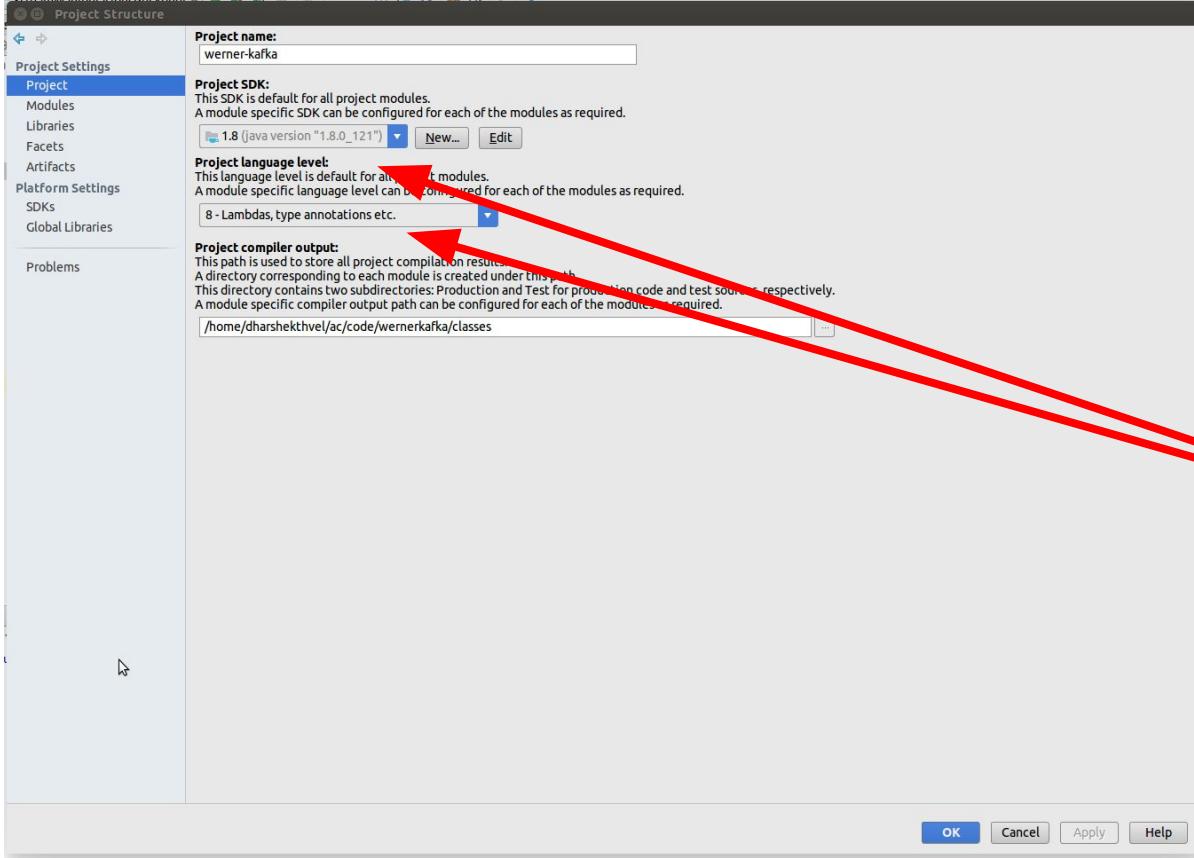


Ensure that you
have done 1.8

IntelliJ IDE

Byte Code not supported at this level

File → Project Structure → project



Ensure that you
have done 1.8

Pycharm - Spark Setup



Pycharm - Spark Setup

File -> Settings...

SparkBasic - ~/PycharmProjects/SparkBasic - .../sparkpackage/spark_word_count.py - PyCharm Community Edition 2017.1.1

File Edit View Navigate Code Refactor Run Tools VCS Window Help

New Project... **Settings...** Default Settings... Import Settings... Export Settings... Settings Repository... Save All Synchronize Invalidate Caches / Restart... Print... Power Save Mode Exit

New... New Scratch File Open... Save As... Open Recent Close Project Rename Project... Default Settings... Import Settings... Export Settings... Settings Repository... Save All Synchronize Invalidate Caches / Restart... Print... Power Save Mode Exit

spark_word_count

```
from __future__ import print_function
from pyspark.conf import SparkConf
from pyspark.context import SparkContext

config = SparkConf()
config.setAppName("SPARK_WORD_COUNT_JOB")
config.setMaster("local[*]")

sc = SparkContext(config=config)
sc.setLogLevel("info")
text_file = sc.textFile("/home/dharshekthvel/PycharmProjects/SparkBasic/sparkpackage/spark_word_count.py")
flat_mapped_rdd = text_file.flatMap(lambda mapped_rdd = flat_mapped_rdd.map(lambda each_mapped_rdd.reduceByKey(lambda x,y): (x+y)).foreach(print)
```

17/05/17 01:32:48 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using java.library.path: /home/dharshekthvel/anaconda2/bin/python /home/dharshekthvel/PycharmProjects/SparkBasic/sparkpackage/spark_word_count.py

Setting default log level to "WARN".

To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).

17/05/17 01:32:48 WARN Utils: Your hostname, dharshekthvel resolves to a loopback address: 127.0.1.1, instead of a public one. You should consider changing your host IP address or hostname.

17/05/17 01:32:48 INFO MemoryStore: Block broadcast_0 stored as values in memory (estimated size 236.5 KB).

17/05/17 01:32:48 INFO BlockManagerInfo: Added broadcast_0_piece0 in memory on 127.0.1.1:39349 (size: 236.5 KB, blocks: 1, free: 192.5 MB).

17/05/17 01:32:48 INFO SparkContext: Created broadcast_0 from textFile at NativeMethodAccessorImpl.java:271

17/05/17 01:32:48 INFO InputFormat: Total input paths to process : 1

17/05/17 01:32:48 INFO SparkContext: Starting job: foreach at /home/dharshekthvel/PycharmProjects/SparkBasic/spark_word_count.py

17/05/17 01:32:50 INFO DAGScheduler: Registering RDD 3 (reduceByKey at /home/dharshekthvel/PycharmProjects/SparkBasic/spark_word_count.py)

17/05/17 01:32:50 INFO DAGScheduler: Got job 0 (foreach at /home/dharshekthvel/PycharmProjects/SparkBasic/spark_word_count.py)

17/05/17 01:32:50 INFO DAGScheduler: Final stage: ResultStage 1 (foreach at /home/dharshekthvel/PycharmProjects/SparkBasic/spark_word_count.py)

17/05/17 01:32:50 INFO DAGScheduler: Parents of final stage: List(ShuffleMapStage 0)

17/05/17 01:32:50 INFO DAGScheduler: Missing parents: List(ShuffleMapStage 0)

17/05/17 01:32:50 INFO DAGScheduler: Submitting ShuffleMapStage 0 (PairwiseRDD[3] at reduceByKey at /home/dharshekthvel/PycharmProjects/SparkBasic/spark_word_count.py)

17/05/17 01:32:50 INFO MemoryStore: Block broadcast_1 stored as values in memory (estimated size 9.5 KB).

17/05/17 01:32:50 INFO BlockManagerInfo: Added broadcast_1_piece0 in memory on 127.0.1.1:39349 (size: 9.5 KB).

17/05/17 01:32:50 INFO SparkContext: Created broadcast 1 from broadcast at DAGScheduler.scala:99

17/05/17 01:32:50 INFO DAGScheduler: Submitting 2 missing tasks from ShuffleMapStage 0 (PairwiseRDD[3])

17/05/17 01:32:50 INFO TaskSchedulerImpl: Adding task set 0.0 with 2 tasks

17/05/17 01:32:50 INFO TaskSetManager: Starting task 0.0 in stage 0.0 (TID 0, localhost, executor driv

17/05/17 01:32:50 INFO Executor: Running task 0.0 in stage 0.0 (TID 0)

17/05/17 01:32:50 INFO Executor: Running task 1.0 in stage 0.0 (TID 1)

17/05/17 01:32:50 INFO HadoopRDD: Input split: file:/home/dharshekthvel/history 1.txt@11055+11055

17/05/17 01:32:50 INFO HadoopRDD: Input split: file:/home/dharshekthvel/history 1.txt@0+11055

17/05/17 01:32:50 INFO deprecation: mapred.tip.id is deprecated. Instead, use mapreduce.task.id

17/05/17 01:32:50 INFO deprecation: mapred.task.id is deprecated. Instead, use mapreduce.task.attempt.

17/05/17 01:32:50 INFO deprecation: mapred.task.is.map is deprecated. Instead, use mapreduce.task.isma

17/05/17 01:32:50 INFO deprecation: mapred.task.partition is deprecated. Instead, use mapreduce.task.p

17/05/17 01:32:50 INFO deprecation: mapred.job.id is deprecated. Instead, use mapreduce.job.id

17/05/17 01:32:50 INFO PythonRunner: Times: total = 240, boot = 222, init = 10, finish = 8

17/05/17 01:32:50 INFO PythonRunner: Times: total = 239, boot = 220, init = 12, finish = 7

17/05/17 01:32:50 INFO Executor: Finished task 0.0 in stage 0.0 (TID 0). 2048 bytes result sent to driver

17/05/17 01:32:50 INFO Executor: Finished task 1.0 in stage 0.0 (TID 1). 2127 bytes result sent to driver

17/05/17 01:32:50 INFO TaskSetManager: Finished task 1.0 in stage 0.0 (TID 1) in 445 ms on localhost (slot 0)

17/05/17 01:32:50 INFO TaskSetManager: Finished task 0.0 in stage 0.0 (TID 0) in 464 ms on localhost (slot 0)

17/05/17 01:32:50 INFO TaskSchedulerImpl: Removed TaskSet 0.0, whose tasks have all completed, from pool

17/05/17 01:32:50 INFO DAGScheduler: ShuffleMapStage 0 (reduceByKey at /home/dharshekthvel/PycharmProjects/SparkBasic/spark_word_count.py)

17/05/17 01:32:50 INFO DAGScheduler: looking for newly runnable stages

17/05/17 01:32:50 INFO DAGScheduler: running: Set()

17/05/17 01:32:50 INFO DAGScheduler: waiting: Set(ResultStage 1)

17/05/17 01:32:50 INFO DAGScheduler: failed: Set()

17/05/17 01:32:50 INFO DAGScheduler: Submitting ResultStage 1 (PythonRDD[6] at foreach at /home/dharshekthvel/PycharmProjects/SparkBasic/spark_word_count.py)

17/05/17 01:32:50 INFO MemoryStore: Block broadcast_2_stored as values in memory (estimated size 2.0 KB).

17/05/17 01:32:50 INFO BlockManagerInfo: Added broadcast_2_piece0 in memory on 127.0.1.1:39349 (size: 2.0 KB).

Your source code contains __future__ imports.

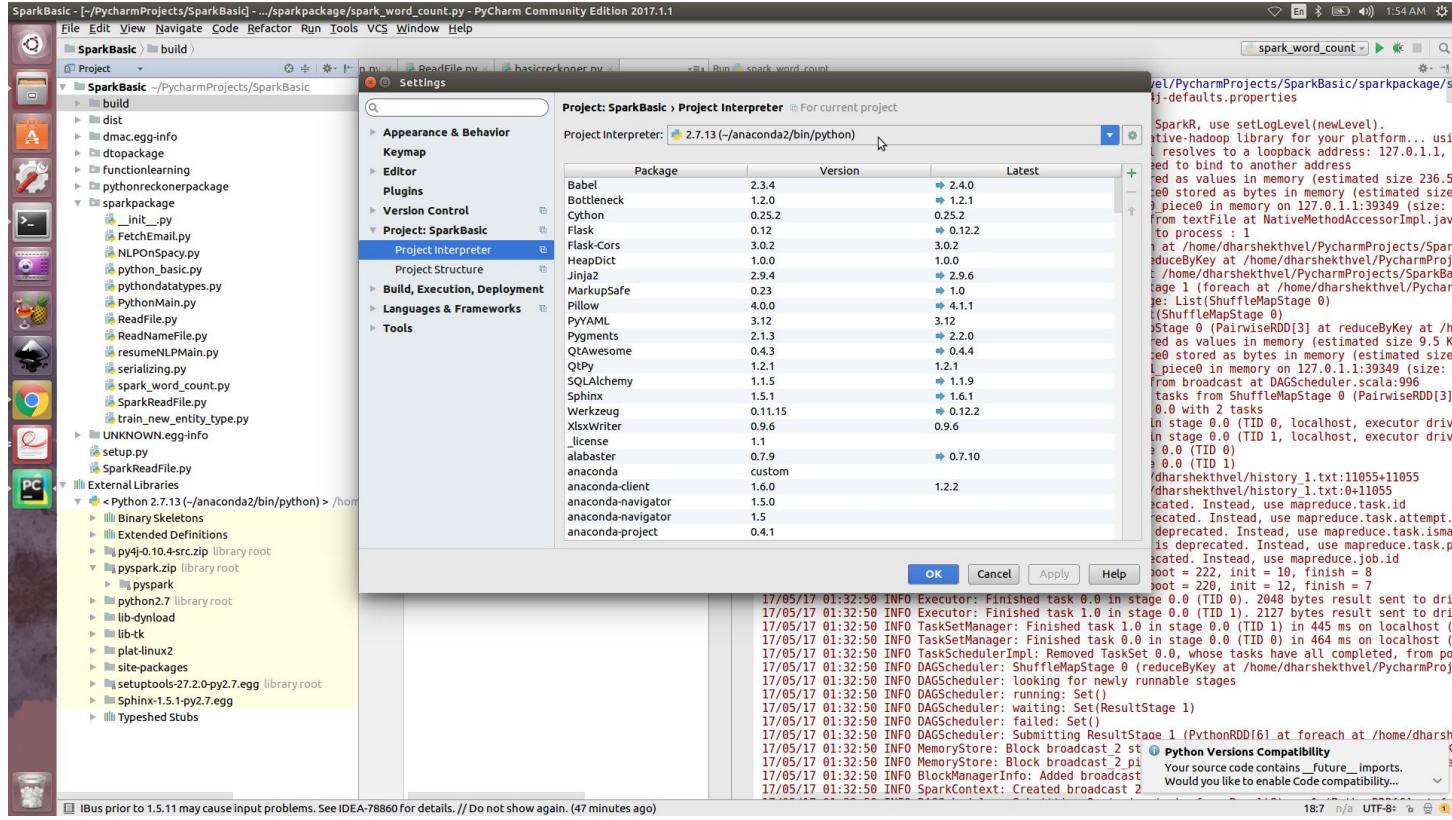
Would you like to enable Code compatibility...

chin

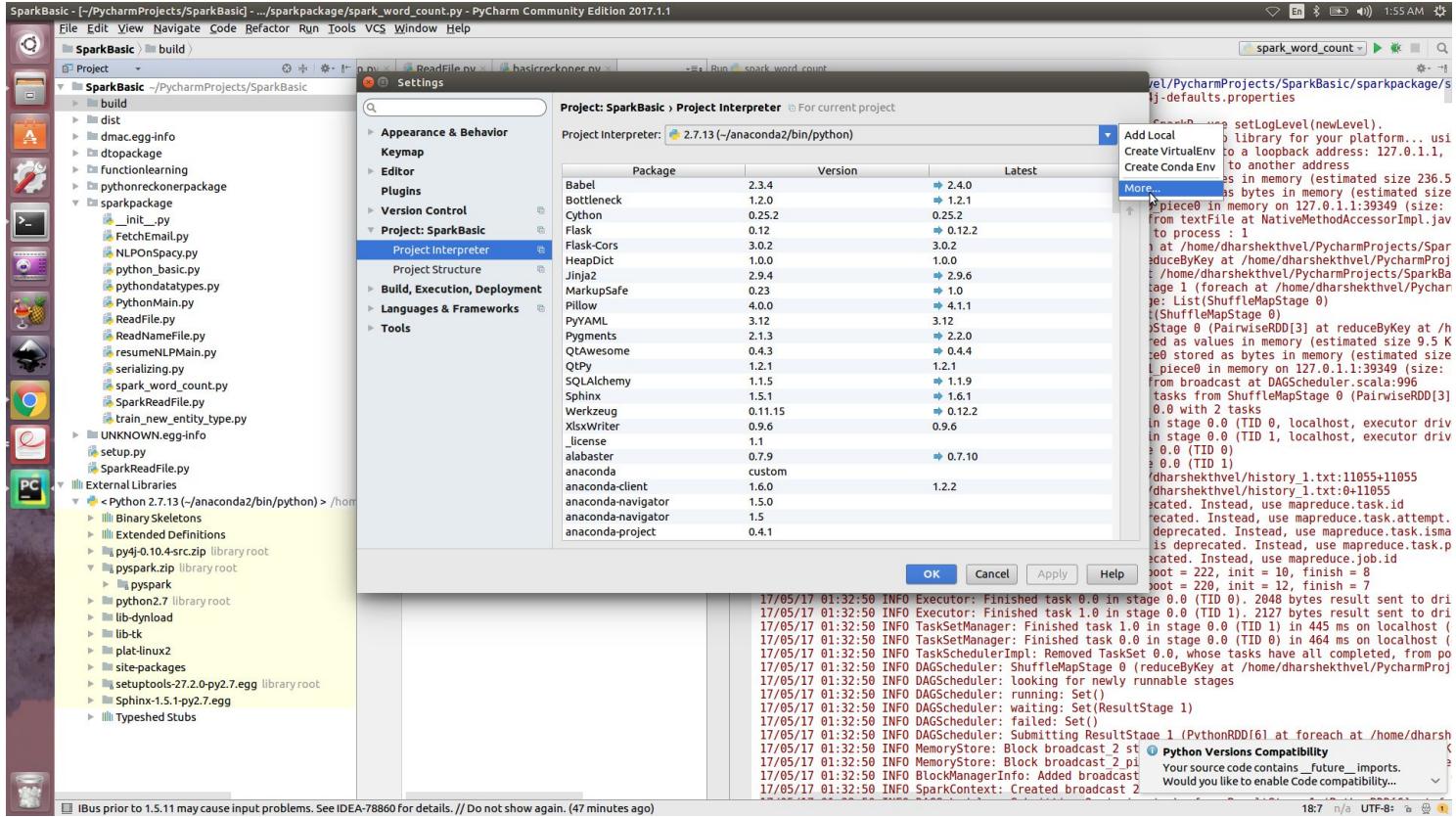
Edit application settings

44:32 n/a UTF-8 1

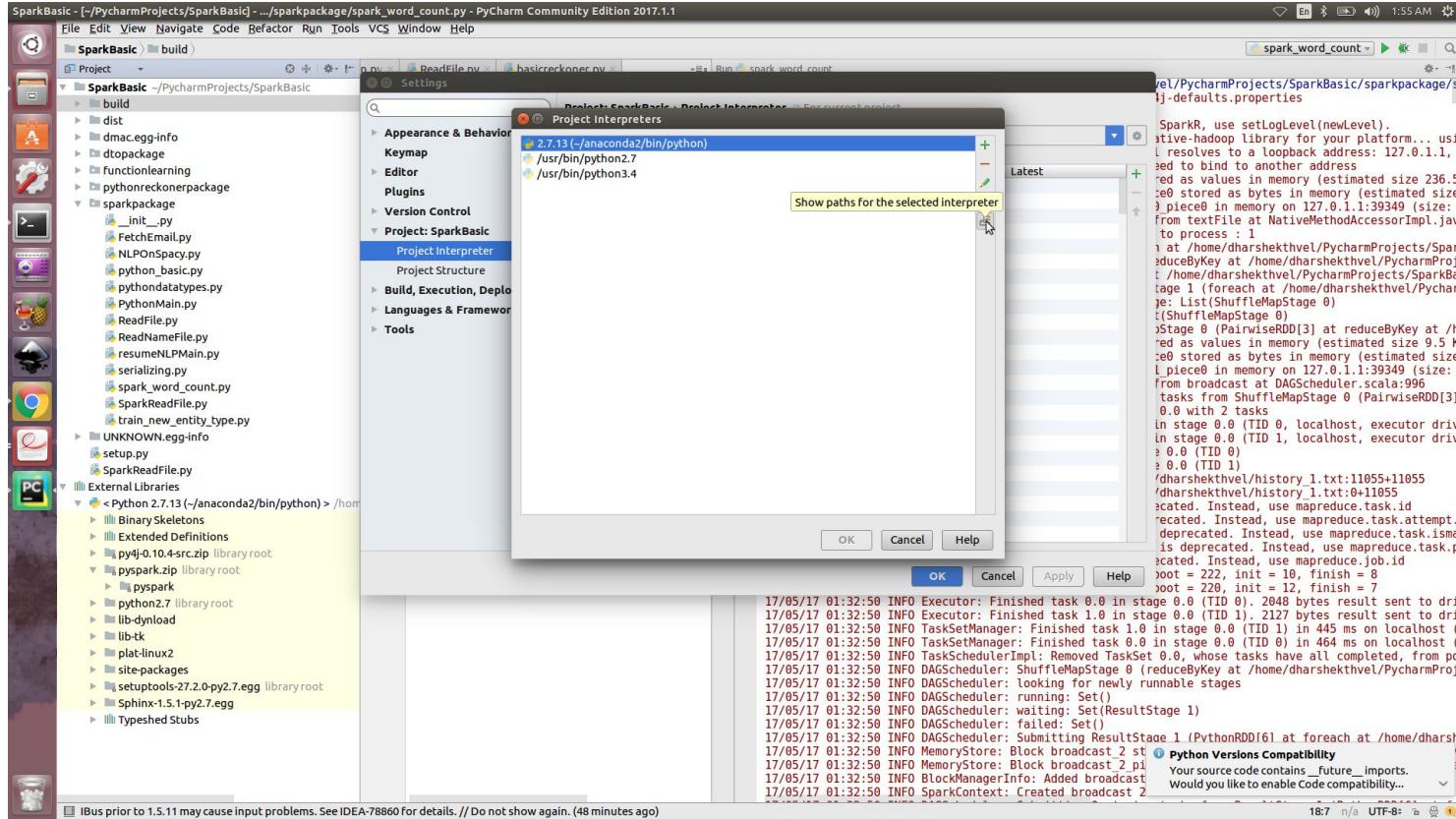
Pycharm - Spark Setup



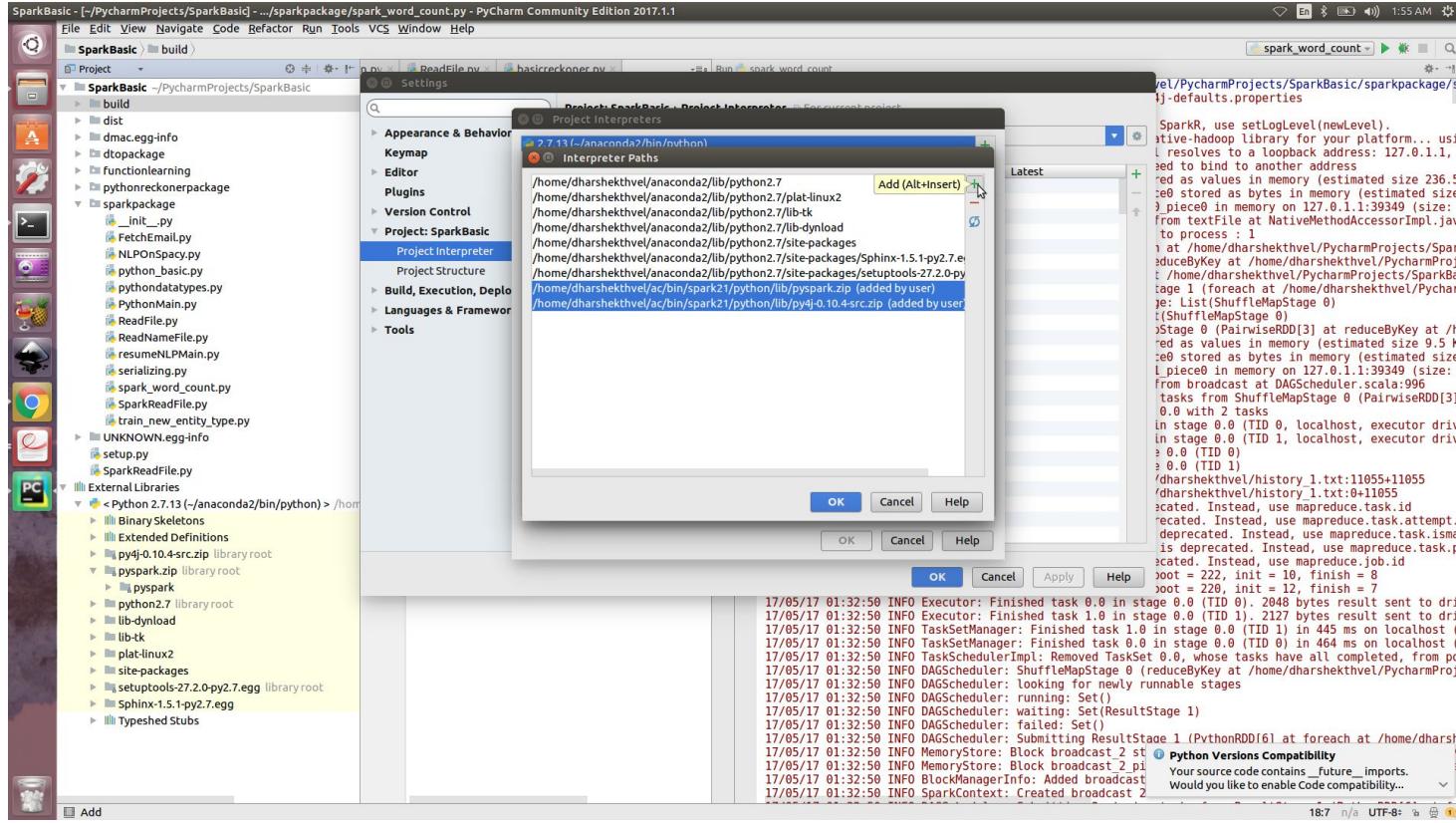
Pycharm - Spark Setup



Pycharm - Spark Setup



Pycharm - Spark Setup





Agenda

- [] Big Data - Why, What and How
- [] Spark, Why Spark
- [] RDD
- [] JDK 8 (Functional Programming and Lambda Expressions) - If needed
- [] Transformations and Actions
- [] Caching, Storage Levels
- [] Broadcasts and Accumulators
- [] Spark Internals
- [] Spark UI, Job History Server
- [] SparkSQL - DataFrames
- [] SparkStreaming - DStreams
- [] Spark Performance Tuning
- [] Machine Learning

What is Spark ?

Spark is a fast, general computation engine
for large scale data processing
running on a cluster.

Spark - History

Matei Zaharia started Spark and later in 2013 was donated to Apache.



Algorithms,
Machines,
People



Spark Advantages

Fault - Tolerance

Data is distributed when it is stored

Bring computation to the data

High level programming framework

Hides the plumbing, we can focus on the code

Caches data in memory

Spark Advantages

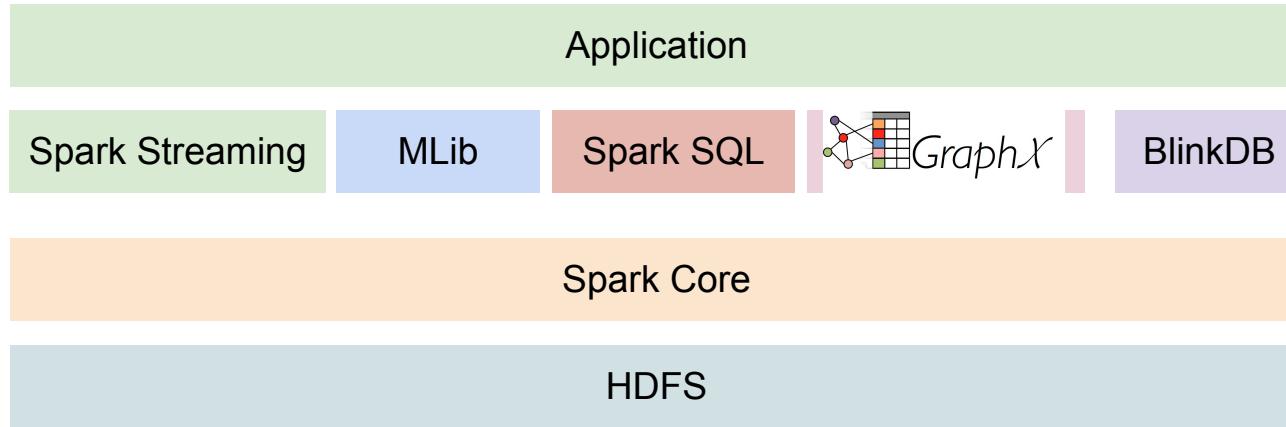
Lazy computations

Optimize the job before executing

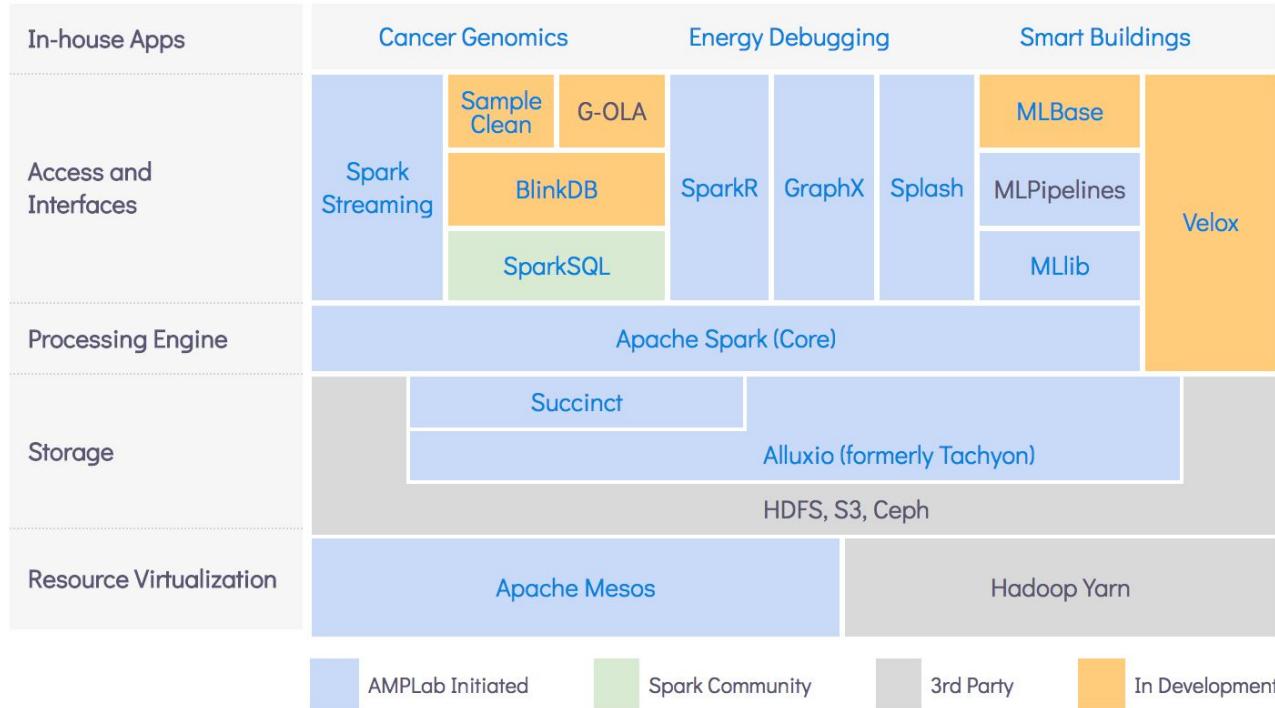
In memory caching

Scan the hard-disk and then scan the RAM

BDAS - Berkeley Data Analytics Stack



BDAS - Berkeley Data Analytics Stack



Source : <https://amplab.cs.berkeley.edu/software/>

Difference between Storm and Spark



Task Parallel

Data Parallel

Heron is replacing it.

No replacement

Less community active

Active community

Misconceptions about Spark

It is an in-memory computation engine, it just uses memory for its LRU cache.

It is 100x faster than Hadoop.

Spark's approach to data is completely a novice approach.

View the spark source code.

Writing custom RDD is a good in scala.

To learn the internals of the spark, scanning source code is mandatory.

For Java Developers . . .

chinnasamyad@gmail.com



Spark
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Era of Functional Programming

Functional programming is a programming paradigm (a style of coding)

Spark uses functional programming model heavily to code on the data.

What is an RDD ?

The Resilient Distributed Dataset (RDD) is the founding data structure of Spark.

An RDD is an abstraction of a collection of data distributed on various nodes.

RDD is a dataset that is distributed and divided into partitions.

It is distributed, immutable, lazily evaluated, type inferred and cacheable.

RDD's are immutable, distributed and fault-tolerant

RDD's are immutable meaning, any RDD created is computed and given to user. An RDD created is never destroyed.

Distributedness comes from the fact that data is distributed across various partitions which in turn is stored across various nodes.

Since data is available across nodes, there is no possibility of data loss and hence fault tolerant.

Structure of a Spark Program

1. Create a Spark Config
2. Then create a spark context from the spark config
3. Write one or more transformations.
4. Atlast write only one action.
5. Close the Spark Context.

Spark Context - sc

```
SparkConf sparkConfig = new SparkConf()  
    .setAppName("ReadCSVFile")  
    .setMaster("local[8]");
```

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);
```

```
javaSparkContext.close();  
(or)  
javaSparkContext.stop();
```

Spark Context - Read a File

```
    javaSparkContext.textFile("file:///C:/ac/spark/code/sparktraining/data/titanic3.csv")
        .foreach(eachLine -> System.out.println(eachLine));
```

textFile is the transformation, and
foreach is the action.

We will learn what is a transformation and action a little later. Both are api's in spark but for a different purpose.

Spark Config

```
SparkConf sparkConfig = new SparkConf()  
    .set("spark.local.dir", "/Users/tester/whitetiger")  
    .setAppName("ReadCSVFile")  
    .setMaster("local[8]");
```

To get rid of the logs printing in the console, put the following code before the Spark Config:

```
import org.apache.log4j.{Level, Logger}  
val rootLogger = Logger.getRootLogger()  
rootLogger.setLevel(Level.ERROR)
```

Spark Config

To get rid of the logs printing in the console, put the following code before the Spark Config:

```
import org.apache.log4j.{Level, Logger}  
Logger.getLogger("org").setLevel(Level.OFF)
```

Spark Config

```
SparkConf sparkConfig = new SparkConf()  
    .set("spark.local.dir", "/Users/tester/whitetiger")  
    .setAppName("ReadCSVFile")  
    .setMaster("local[8]");
```

```
sparkConfig.set("spark.driver.host", "localhost")
```

```
sparkConfig.set("spark.driver.allowMultipleContexts", "true")
```

Spark - pyspark first program



```
from pyspark import SparkContext
```

```
sc = SparkContext()  
lines = sc.parallelize(['first','spark','code'])  
  
for each in lines.take(10):  
    print each
```

```
from pyspark import SparkContext  
from pyspark.conf import SparkConf  
  
config = SparkConf()  
  
config.setAppName("SPARK_READ_FILE_JOB")  
config.setMaster("local[*]")  
sc = SparkContext(conf=config)
```

```
def print_each_line(eachLine):  
    print eachLine  
    return
```

```
textFileRDD = sc.textFile("/home/dharshekthvel/history_1.txt")  
mappedRDD = textFileRDD.map(lambda x : len(x))
```

pyspark - avoid winutils exception



```
# If you get a winutils.exe exception then add the below line  
# Put the winutils.exe in the bin folder inside D:/ac/winutils/bin
```

```
import os
```

```
os.environ['HADOOP_HOME'] = "D:/ac/winutils/"
```

Spark Session

SparkSession is the new entry point for spark from Spark 2.0.

SparkSession is the new unified gateway for SQLContext, Streaming Context futuristically.

Spark Session

```
val sparkSession = SparkSession.builder()
    .appName("SparkJOB")
    .master("local[*]")
    .config("spark.local.dir","/Users/dharshekthvel/ac")
    .getOrCreate()
```

```
val sparkContext = sparkSession.sparkContext
```

```
val file = sparkContext.textFile("/Users/dharshekthvel/ac/auth.csv")
```

```
file.foreach(eachLine => println(eachLine))
```

```
sparkContext.stop()
```

Spark - Shell

Spark shell is a command line utility which gives spark context (sc) by which any spark API can be evaluated. It is based on REPL (Read-Eval-Print-Loop)

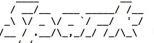
`./spark-shell` which resides in bin directory of the spark installation. This starts in the spark scala REPL.

`./pyspark` which resides in bin directory of the spark installation. This starts in the spark python REPL.

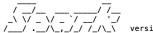
Spark - Shell

Scala REPL

Python REPL

```
1>%%cd ls:2:18:18 INFO sparkEnv: registering mapoutputtracker
15/07/26 13:59:58 INFO SparkEnv: Registering BlockManagerMaster
15/07/26 13:59:58 INFO DiskBlockManager: Created local directory at /var/folders/fs/7n_kjky94b5d0xs_wbkt258c0000gp/T/spark-73aa0b0f-a05f-4941-9430-23cadef75c0
e0#
15/07/26 13:59:58 INFO MemoryStore: MemoryStore started with capacity 265.4 MB
15/07/26 13:59:58 INFO HttpFileServer: HTTP File server directory is /var/folders/fs/7n_kjky94b5d0xs_wbkt258c0000gp/T/spark-94d8543c-6bee-4e26-bfa9-c344da126l
b
15/07/26 13:59:58 INFO HttpServer: Starting HTTP Server
15/07/26 13:59:58 INFO Server: jetty-8.y.z-SNAPSHOT
15/07/26 13:59:58 INFO AbstractConnector: Started SocketConnector@0.0.0.0:59160
15/07/26 13:59:58 INFO Utils: Successfully started service "HTTP file server" on port 59160.
15/07/26 13:59:58 INFO SparkEnv: Registering OutputCommitCoordinator
15/07/26 13:59:58 INFO Server: jetty-8.y.z-SNAPSHOT
15/07/26 13:59:58 INFO AbstractConnector: Started SelectChannelConnector@0.0.0.0:4040
15/07/26 13:59:58 INFO Utils: Successfully started service "SparkUI" on port 4040.
15/07/26 13:59:58 INFO SparkUI: Started SparkUI at http://localhost:4040
15/07/26 13:59:58 INFO Executor: Executor successfully registered to HeartbeatReceiver at akka.tcp://sparkDriver@localhost:59159/user/HeartbeatReceiver
15/07/26 13:59:59 INFO NettyBlockTransferService: Server created on 59161
15/07/26 13:59:59 INFO BlockManagerMasterActor: Trying to register BlockManager
15/07/26 13:59:59 INFO BlockManagerMasterActor: Registering block manager localhost:59161 with 265.4 MB RAM, BlockManagerId(<driver>, localhost, 59161)
15/07/26 13:59:59 INFO BlockManagerMaster: Registered BlockManager
Welcome to
 version 1.3.1
```

Using Python version 2.7.5 (default, Mar 9 2014 22:15:05)
SparkContext available as sc, HiveContext available as sqlContext.
>>> %%

```
15/07/26 13:59:26 INFO HttpServer: Starting HTTP Server
15/07/26 13:59:26 INFO Server: jetty-8.y.z-SNAPSHOT
15/07/26 13:59:26 INFO AbstractConnector: Started SocketConnector@0.0.0.0:59158
15/07/26 13:59:26 INFO Utils: Successfully started service "HTTP class server" on port 59158.
Welcome to
 version 1.3.1

Using Scala version 2.10.4 (Java HotSpot(TM) 64-Bit Server VM, Java 1.7.0_45)
Type in expressions to have them evaluated.
Type :help for more information.
15/07/26 13:59:29 WARN Util: Your hostname, localhost resolves to a loopback address: 127.0.0.1, but we couldn't find any external IP address!
15/07/26 13:59:29 WARN Util: Set SPARK_LOCAL_IP if you need to bind to another address
15/07/26 13:59:29 INFO SparkContext: Running Spark version 1.3.1
15/07/26 13:59:29 INFO SparkContext: Using org.apache.spark.repl.SparkREPL as the repl
15/07/26 13:59:29 INFO SecurityManager: Changing view acls acts to: tester
15/07/26 13:59:29 INFO SecurityManager: authentication disabled; ui acls disabled; users with view permissions: Set(testner); users with modify : Set()
15/07/26 13:59:29 INFO SecurityManager: SecurityManager: log4jRootCategory = INFO
15/07/26 13:59:29 INFO Remoting: Starting Remoting
15/07/26 13:59:29 INFO Remoting: Remoting started; listening on addresses :[akka.tcp://sparkDriver@localhost:59151]
15/07/26 13:59:29 INFO Remoting: Remoting started; listening on addresses :[akka.tcp://sparkDriver@localhost:59151]
15/07/26 13:59:29 INFO SparkEnv: Registering BlockManagerMaster
15/07/26 13:59:29 INFO SparkEnv: Registering BlockManagerMaster
15/07/26 13:59:29 INFO DiskBlockManager: Created local directory at /var/folders/fs/7n_kjky94b5d0xs_wbkt258c0000gp/T/spark-87809d54-741c-463f-9365-71e88eff04ed/l
b1
15/07/26 13:59:29 INFO MemoryStore: MemoryStore started with capacity 265.4 MB
15/07/26 13:59:29 INFO HttpFileServer: HTTP File server directory is /var/folders/fs/7n_kjky94b5d0xs_wbkt258c0000gp/T/spark-961c5d98-f57c-42f5-9269-437b07c480ee,
2
15/07/26 13:59:29 INFO HttpServer: Starting HTTP Server
15/07/26 13:59:29 INFO Server: jetty-8.y.z-SNAPSHOT
15/07/26 13:59:29 INFO AbstractConnector: Started SelectChannelConnector@0.0.0.0:59152
15/07/26 13:59:29 INFO Utils: Successfully started service "HTTP file server" on port 59152.
15/07/26 13:59:29 INFO SparkEnv: Registering OutputCommitCoordinator
15/07/26 13:59:29 INFO Executor: Starting executor ID driver@ on host localhost
15/07/26 13:59:29 INFO AbstractConnector: Started SelectChannelConnector@0.0.0.0:4840
15/07/26 13:59:29 INFO Utils: Successfully started service "SparkUI" on port 4840.
15/07/26 13:59:29 INFO Executor: Starting executor ID driver@ on host localhost
15/07/26 13:59:29 INFO Executer: Starting executor ID driver@ on host localhost
15/07/26 13:59:29 INFO Executor: Using REPL class URL: http://127.0.0.1:59158
15/07/26 13:59:29 INFO Executor: Using REPL class URL: http://127.0.0.1:59158
15/07/26 13:59:29 INFO Executor: Using REPL class URL: http://127.0.0.1:59158
15/07/26 13:59:29 INFO Executor: Using REPL class URL: http://127.0.0.1:59158
15/07/26 13:59:29 INFO Executor: Using REPL class URL: http://127.0.0.1:59158
15/07/26 13:59:29 INFO BlockManagerMaster: Trying to register BlockManager
15/07/26 13:59:29 INFO BlockManagerMaster: Registered BlockManager
15/07/26 13:59:29 INFO BlockManagerMaster: Registered BlockManager
15/07/26 13:59:30 INFO SparkILoop: Created spark context.
SparkContext available as sc
15/07/26 13:59:30 INFO SparkILoop: Created sql context (with Hive support)..
SQL context available as sqlContext.
scala> %%
```

Spark - Shell

To quit from the shell

`scala> :quit`

Read all files inside a directory

Spark can read the whole content of the directory

For that, **wholeTextFiles()** API of the spark context is used.

After which, the filename and the file content can be accessed seperately.

Read all files inside a directory

```
val sparkContext = new SparkContext(config)

val allFilesRDD = sparkContext.wholeTextFiles("file:///D:/ac/data");
allFilesRDD.foreach(x => println(x._1 + x._2))
```

x._1 gives the filename
x._2 gives the file content

SparkReadFile.java

Spark Running Modes

local mode

- local : Runs spark locally without any parallelism
- local[k] : Runs spark locally with k threads. Usually k is the number of cores of the machine.
- local[*] : Runs spark locally with many threads.

Spark Cluster

```
SparkConf sparkConfig = new SparkConf()  
    .setAppName("ReadLogFile")  
    .setMaster("spark://Apples-MacBook-Pro.local:7077");
```

eg: spark://ec2-52-24-58-38.us-west-2.compute.amazonaws.com:7077

Yarn (Yet Another Resource Negotiator)

Mesos

Simple map transformation

```
SparkConf sparkConfig = new SparkConf()
    .set("spark.local.dir", "/Users/tester/whitetiger")
    .setAppName("ReadCSVFile")
    .setMaster("local[8]");

JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);

JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/tester/ac/entitlement_view.csv");

JavaRDD<LicenseCountDataObject> lcRDD = rdd.map(new Function<String, LicenseCountDataObject>() {

    @Override
    public LicenseCountDataObject call(String input) throws Exception {
        String[] splitColumns = input.split(",");
        LicenseCountDataObject lcObject = new LicenseCountDataObject();
        lcObject.setId(splitColumns[0]);
        lcObject.setLicenseCount(splitColumns[3]);
        return lcObject;
    }
});

lcRDD.foreach(z -> System.out.println(z.getId()));
javaSparkContext.stop();
```

Simple map transformation

```
class UNBeanConverterFunction implements Function<String,  
UNDataBean> {
```

```
/**  
 *  
 */
```

```
private static final long serialVersionUID = 1L;
```

```
@Override
```

```
public UNDataBean call(String input) throws Exception {
```

```
String[] splitColumns = input.split(",");
```

```
UNDataBean undata = new UNDataBean();
```

```
undata.setCountry(splitColumns[0]);
```

```
undata.setCommodityCode(splitColumns[2]);
```

```
undata.setCommodity(splitColumns[3]);
```

```
return undata;
```

```
}
```

JavaRDD<UNDataBean> undataBeanconverterRDD
= rdd.map(new UNBeanConverterFunction());

Simple map transformation

The same functional program as a part of lambda expression.

```
JavaRDD<UNDataBean> undataBeanRDD = rdd.map((each) -> {  
    String[] splitColumns = each.split(",");  
  
    UNDataBean undata = new UNDataBean();  
    undata.setCountry(splitColumns[0]);  
    undata.setCommodityCode(splitColumns[2]);  
    undata.setCommodity(splitColumns[3]);  
    return undata;  
});
```

Simple map transformation - Scala

```
object SparkScalaMapTransformation {  
  
    def main(args: Array[String]) {  
  
        val config = new SparkConf().setAppName("ReadCSVFile").setMaster("local[8]")  
        val sc = new SparkContext(config)  
  
        val titanicText = sc.textFile("file:///Users/apple/titanic3.csv")  
  
        titanicText.map(new TitanicBeanConverter().titanicBeanConverter)  
            .foreach(x => println(x.name))  
    }  
  
    class TitanicBeanConverter extends Serializable {  
  
        def titanicBeanConverter(line : String) : TitanicBean = {  
            val titanicBean = new TitanicBean()  
            titanicBean.name = line.split(",")(2)  
  
            return titanicBean  
        }  
    }  
}
```

```
class TitanicBean {  
    var className = ""  
    var survived = ""  
    var name = ""  
    var sex = ""  
    var age = ""  
    var sibsp = ""  
    var parch = ""  
    var ticket = ""  
    var fare = ""  
    var cabin = ""  
    var embarked = ""  
    var boat = ""  
    var body = ""  
    var destination = ""  
}
```

Simple map transformation - pyspark

```
from pyspark import SparkContext
from pyspark.conf import SparkConf

config = SparkConf()

config.setAppName("SPARK_READ_FILE_JOB")
config.setMaster("local[*]")
sc = SparkContext(conf=config)

def print_each_line(eachLine):
    print eachLine
    return

textFileRDD = sc.textFile("/home/dharshekthvel/history_1.txt")
mappedRDD = textFileRDD.map(lambda x : len(x))

mappedRDD.foreach(print_each_line)
```

Lazy Evaluation of RDD

RDD's are lazily evaluated, emphasizing the fact that RDD's will get evaluated by spark only when an action is encountered.

If you see a log as shown below, then it means that Spark has done a action on the RDD.

```
15/07/26 12:08:08 INFO HadoopRDD: Input split: file:/Users/tester/ac/entitlement_view.csv:106634+106635  
15/07/26 12:08:08 INFO HadoopRDD: Input split: file:/Users/tester/ac/entitlement_view.csv:0+106634
```

Different ways of creating an RDD

[] Loading from an external dataset

```
javaSparkContext.textFile("file:///Users/apple/titanic3.csv")
    .foreach(z -> System.out.println(z));
```

```
javaSparkContext.textFile("hdfs://localhost:9000/data/titanic3.csv")
    .foreach(z -> System.out.println(z));
```

[] Parallelize from the Spark Context by giving an input list

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);
List<LatLong> locationList = new ListSource().retrieveList();
JavaRDD<LatLong> locRDD = javaSparkContext.parallelize(locationList);
```

[] Creating an RDD from another RDD.

Different ways of creating an RDD

- [] Use makeRDD of sparkContext

```
val supportVectorList = List(  
    SVMSupportVector("mesh", "12", 1),  
    SVMSupportVector("maille", "15", 2),  
    SVMSupportVector("referential", "33", 2))  
  
val rdd = sparkContext.makeRDD(supportVectorList)
```

- [] A Range RDD can be created from SparkContext

```
val rangeRDD = sparkContext.range(1, 100, 2, 10)
```

1 to 100 by 2, with 10 partitions

Different ways of creating an RDD

- [] Use hadoopFile() to build your own custom format

```
val.hadoopFileRDD = sparkContext.hadoopFile[LongWritable,Text,TextInputFormat]("file:///home/dharshekthvel/ac/docs/file.txt")
.map { case (x,y) => y.toString }
```

```
hadoopFileRDD.foreach(x => println(x))
```

Multiple spark context

```
val sparkSession = SparkSession .builder()
    .appName("SparkJOB")
    .master("local")
    .config("spark.driver.allowMultipleContexts", "true")
    .getOrCreate
```

```
val sparkContext = sparkSession.sparkContext
```

```
val sparkSessionOne = SparkSession .builder()
    .appName("SparkJOBOne")
    .master("local")
    .config("spark.driver.allowMultipleContexts", "true")
    .getOrCreate
```

```
val sparkContextOne = sparkSession.sparkContext
```

Dependency Handling with libraries and files

[] Adding a File

```
sparkContext.addFile("path")
SparkFiles.get("path")
```

Downloads the file present at path to every node. The file can be accessed in the worker node via `SparkFiles.get("path")`

[] Adding a Jar

```
sparkContext.addJar("path");
```

Adds the file at path as a JAR dependency for all tasks executed in the Spark Context.

Spark 2.0 Features

DataFrames is the type alias for Dataset. Path is on for the unification of DataSets and DataFrames.

More performance oriented Accumulator API. Accumulator supports primitives.

Spark 2.0 has the Tungsten engine for performance optimization. The tungsten optimization is called as the "whole-stage code generation".

The tungsten code generation can be turned off using `SparkSession.config("spark.sqlcodegen.wholeStage", "false")`

Catalyst optimizer for general query optimization is also introduced.

Structured streaming has been introduced.

Spark 2.0 Features

High optimization is done in Spark 2.0. As said, Spark 2.0 ships with a Tungsten engine. The engine is built upon the idea of modern compilers and MPP databases and applies them to data processing.

maven dependencies

```
<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-core_2.10</artifactId>
  <version>1.4.0</version>
</dependency>

<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-streaming_2.10</artifactId>
  <version>1.4.0</version>
</dependency>

<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-sql_2.10</artifactId>
  <version>1.4.0</version>
</dependency>
```

Spark Core

Spark Streaming

SparkSQL

```
<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-mllib_2.10</artifactId>
  <version>1.4.0</version>
</dependency>

<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-streaming-twitter_2.10</artifactId>
  <version>1.5.0</version>
</dependency>

<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-streaming-kafka_2.10</artifactId>
  <version>1.4.0</version>
</dependency>
```

Spark Machine Learning

Twitter Streaming

Kafka Streaming

sbt dependencies

```
name := "sparkscala9"

version := "1.0"

scalaVersion := "2.11.7"

libraryDependencies ++= Seq(
    "org.apache.spark" %% "spark-core" % "1.6.0",
    "org.apache.spark" %% "spark-sql" % "1.6.0",
    "org.apache.spark" %% "spark-streaming" % "1.6.0",
    "org.apache.spark" %% "spark-streaming-kafka" % "1.6.0"
)

resolvers += "Akka Repository" at "http://repo.akka.io/releases/"
```

Spark

```
name := "sparkscala9"

version := "1.0"

scalaVersion := "2.11.7"

libraryDependencies += Seq(
    "org.apache.spark" %% "spark-core" % "1.6.0",
    "org.apache.spark" %% "spark-sql" % "1.6.0",
    "org.apache.spark" %% "spark-streaming" % "1.6.0",
    "org.apache.spark" %% "spark-streaming-kafka" % "1.6.0"
)

resolvers += "Akka Repository" at "http://repo.akka.io/releases/"
```

Spark Standalone Cluster

[1] Start the master

```
$ /sbin/start-master.sh
```

[2] Start the worker

```
$ /bin/spark-class
```

```
org.apache.spark.deploy.worker.Worker  
spark://SCHMAC-TESTER-4.local:7077
```

Start and Stop a Spark standalone cluster (Masters and Workers)

To start a master

```
$ /sbin/start-master.sh
```

After starting the master the below are the successful logs after the start of the master.

```
15/07/24 12:41:43 INFO Remoting: Starting remoting
```

```
15/07/24 12:41:44 INFO Remoting: Remoting started; listening on addresses  
:[akka.tcp://sparkMaster@ec2-52-24-58-38.us-west-2.compute.amazonaws.com:7077]
```

```
15/07/24 12:41:44 INFO Utils: Successfully started service 'sparkMaster' on port 7077.
```

```
15/07/24 12:41:44 INFO Utils: Successfully started service on port 6066.
```

```
15/07/24 12:41:44 INFO StandaloneRestServer: Started REST server for submitting applications on port  
6066
```

Start and Stop a Spark standalone cluster (Masters and Workers)

To start a worker

\$ /bin/spark-class

org.apache.spark.deploy.worker.Worker spark://SCHMAC-TESTER-4.local:7077

\$ cd sbin/
\$./start-slave.sh spark://Dharshekths-MacBook-Pro.local:7077

\$./spark-class org.apache.spark.deploy.worker.Worker
spark://ec2-52-24-58-38.us-west-2.compute.amazonaws.com:7077

The below would be the successful log messages when the worker is added to the master.

15/07/24 13:09:04 INFO Slf4jLogger: Slf4jLogger started

15/07/24 13:09:04 INFO Remoting: Starting remoting

15/07/24 13:09:05 INFO Remoting: Remoting started; listening on addresses :[akka.tcp://sparkWorker@172.31.40.73:47537]

15/07/24 13:09:05 INFO Utils: Successfully started service 'sparkWorker' on port 47537.

15/07/24 13:09:05 INFO Worker: Starting Spark worker 172.31.40.73:47537 with 2 cores, 6.3 GB RAM

15/07/24 13:09:05 INFO Worker: Running Spark version 1.4.0

15/07/24 13:09:05 INFO Worker: Spark home: /home/ubuntu/inferneon/spark14

15/07/24 13:09:05 INFO Utils: Successfully started service 'WorkerUI' on port 8081.

15/07/24 13:09:05 INFO WorkerWebUI: Started WorkerWebUI at http://172.31.40.73:8081

15/07/24 13:09:05 INFO Worker: Connecting to akka.tcp://sparkMaster@ec2-52-24-58-38.us-west-2.compute.amazonaws.com:7077/user/Master...

15/07/24 13:09:05 INFO Worker: Successfully registered with master spark://ec2-52-24-58-38.us-west-2.compute.amazonaws.com:7077

Start and Stop a Spark standalone cluster (Masters and Workers)

To stop a master

```
$ /sbin/stop-master.sh
```

Start and Stop a Spark standalone cluster (Masters and Workers)

To start a cluster, you can also do

\$ /sbin/start-all.sh

The above will start master and all nodes listed in conf/slaves config file.

To stop a cluster,

\$ /sbin/stop-all.sh

Spark Submit

To run spark

```
/spark_installation/bin/spark-submit
```

```
./spark-submit
```

```
--name THIS_IS_MY_APP_NAME  
--master local[*]  
--deploy-mode client          (client or cluster)  
--driver-memory 1G            (Default: 512M)  
--class com.dmac.analytics.spark.SparkSubmitJob  
~/sparktrainingjava-1.0-SNAPSHOT.jar
```

```
./spark-submit
```

```
--properties-file ~/spark_qa.properties  
--class com.dmac.analytics.spark.SparkInternals  
~/sparktrainingjava-1.0-SNAPSHOT.jar
```

```
./spark-submit --help
```

chinnasamyad@gmail.com

Check out help for more options

Spark Submit

spark_qa.properties

spark.master	local
spark.app.name	MY OWN APP NAME
spark.ui.port	1234

The screenshot shows the Spark 1.4.0 web interface with the 'Environment' tab selected. The 'Runtime Information' section lists Java Home, Java Version, and Scala Version. Below it, the 'Spark Properties' section is highlighted with a blue border and lists the following properties:

- Name
- spark.app.id
- spark.app.name
- spark.driver.host
- spark.driver.port
- spark.executor.id
- spark.externalBlockStore.folderName
- spark.fileserver.uri
- spark.jars
- spark.master
- spark.scheduler.mode
- spark.ui.port

The 'spark.ui.port' property in the UI corresponds to the value '1234' in the 'spark_qa.properties' file.

Spark UI

local mode <http://localhost:4040/>

./spark-shell

standalone mode <http://bdsa:8080/>

Starts the web-ui port in 9999 and spark in 8088

./start-master.sh --port 8088 --webui-port 9999

Default is 7077 and 8080

Spark UI

← → ⌂ ⓘ dharshkths-macbook-pro.local:8080/#running-app ⋮

 2.1.0

Spark Master at spark://Dharshkths-MacBook-Pro.local:7077

URL: spark://Dharshkths-MacBook-Pro.local:7077
REST URL: spark://Dharshkths-MacBook-Pro.local:6066 (cluster mode)

Alive Workers: 1
Cores in use: 8 Total, 0 Used
Memory in use: 15.0 GB Total, 0.0 B Used
Applications: 0 [Running](#), 0 [Completed](#)
Drivers: 0 Running, 0 Completed
Status: ALIVE

Workers

Worker Id	Address	State	Cores	Memory
worker-20170203104740-192.168.0.3-51005	192.168.0.3:51005	ALIVE	8 (0 Used)	15.0 GB (0.0 B Used)

Running Applications

Application ID	Name	Cores	Memory per Node	Submitted Time	User	State	Duration

Completed Applications

Application ID	Name	Cores	Memory per Node	Submitted Time	User	State	Duration

Spark UI

Spark 1.4.0

Jobs Stages Storage Environment Executors Streaming

ReadTwitter application UI

Stages for All Jobs

Active Stages: 1

Completed Stages: 15

Active Stages (1)

Stage Id	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Output	Shuffle Read	Shuffle Write
0	start at TwitterStreaming.java:49	+details (kill)	2015/09/18 18:16:51	2.1 min	0/1			

Completed Stages (15)

Stage Id	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Output	Shuffle Read	Shuffle Write
15	print at TwitterStreaming.java:47	+details	2015/09/18 18:18:50	3 ms	1/1			
14	print at TwitterStreaming.java:47	+details	2015/09/18 18:18:40	3 ms	1/1			
13	print at TwitterStreaming.java:47	+details	2015/09/18 18:18:30	3 ms	1/1			
12	print at TwitterStreaming.java:47	+details	2015/09/18 18:18:20	2 ms	1/1			
11	print at TwitterStreaming.java:47	+details	2015/09/18 18:18:10	4 ms	1/1			
10	print at TwitterStreaming.java:47	+details	2015/09/18 18:18:00	4 ms	1/1			
9	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:50	3 ms	1/1			
8	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:40	4 ms	1/1			
7	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:30	3 ms	1/1			
6	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:30	3 ms	1/1			
5	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:20	6 ms	4/4			
4	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:20	3 ms	1/1			
3	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:10	6 ms	1/1			
2	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:00	15 ms	4/4			
1	print at TwitterStreaming.java:47	+details	2015/09/18 18:17:00	18 ms	1/1			

Spark UI



Jobs Stages Storage Environment

Executors

SQL

Spark shell application UI

Executors

Summary

	RDD Blocks	Storage Memory	Disk Used	Cores	Active Tasks	Failed Tasks	Complete Tasks	Total Tasks	Task Time (GC Time)	Input	Shuffle Read	Shuffle Write
Active(1)	12	280.9 KB / 384.1 MB	0.0 B	8	0	0	170	170	21 s (1 s)	7.4 GB	0.0 B	0.0 B
Dead(0)	0	0.0 B / 0.0 B	0.0 B	0	0	0	0	0	0 ms (0 ms)	0.0 B	0.0 B	0.0 B
Total(1)	12	280.9 KB / 384.1 MB	0.0 B	8	0	0	170	170	21 s (1 s)	7.4 GB	0.0 B	0.0 B

Executors

Show 20 entries

Search:

Executor ID	Address	Status	RDD Blocks	Storage Memory	Disk Used	Cores	Active Tasks	Failed Tasks	Complete Tasks	Total Tasks	Task Time (GC Time)	Input	Shuffle Read	Shuffle Write	Thread Dump
driver	192.168.0.3:49818	Active	12	280.9 KB / 384.1 MB	0.0 B	8	0	0	170	170	21 s (1 s)	7.4 GB	0.0 B	0.0 B	Thread Dump

Showing 1 to 1 of 1 entries

[Previous](#) [1](#) [Next](#)

Spark - REST outbounds

<http://localhost:4040/api/v1> - Interfaces are bounded out at /api/v1

<http://localhost:4040/api/v1/applications>

```
[ {  
    "id" : "local-1460702558532",  
    "name" : "ReadLogFile",  
    "attempts" : [ {  
        "startTime" : "2016-04-15T06:42:32.743GMT",  
        "endTime" : "1969-12-31T23:59:59.999GMT",  
        "sparkUser" : "",  
        "completed" : false  
    } ]  
} ]
```

Spark - REST outbound

/applications

/applications/[app-id]/jobs

/applications/[app-id]/jobs/[job-id]

/applications/[app-id]/stages

/applications/[app-id]/stages/[stage-id]

/applications/[app-id]/stages/[stage-id]/[stage-attempt-id]

/applications/[app-id]/stages/[stage-id]/[stage-attempt-id]/taskSummary

/applications/[app-id]/stages/[stage-id]/[stage-attempt-id]/taskList

/applications/[app-id]/executors

/applications/[app-id]/storage/rdd

/applications/[app-id]/**storage**/rdd/[rdd-id]

/applications/[app-id]/logs

Partitions - The core of RDD

An RDD is stored in the memory as partition.

Partition is the logical division of data and helps in parallelism.

Partitions - The core of RDD

The number of partitions can be obtained from `rdd.partitions.length`

```
val textFile = sparkContext.textFile("file:///D:/ac/data/sample.csv")
```

```
println(textFile.partitions.length)
```

or

```
textFile.getNumPartitions
```

Transformations and Actions

Transformation and Actions are the two types of operations supported by the RDD.

Transformation returns a new RDD

map(), filter(), textFile(), distinct(), flatMap(), mapPartitions(), mapPartitionsWithIndex(), sample(), union(), intersection(), groupByKey(), reduceByKey(), aggregateByKey(), sortByKey(), join(), cogroup(), cartesian(), pipe(), coalesce(), repartition(), repartitionAndSortWithinPartitions().

Actions return a result to the driver program

count(), first(), collect(), foreach(), reduce(), count(), take(), takeSample(), takeOrdered(), saveAsTextFile(), saveAsSequenceFile(), saveAsObjectFile(), countByKey().

map and flatMap transformation

map transformation passes each element to the function and returns a new RDD.

flatMap transformation flattens the data to an iterable data set.

Used when making a dataset flatten on nested datasets.

map and flatMap transformation

```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/tester/ac/entitlement_view.csv");
JavaRDD<LicenseCountDataObject> lcRDD = rdd.map(new Function<String, LicenseCountDataObject>() {
    @Override
    public LicenseCountDataObject call(String input) throws Exception {
        String[] splitColumns = input.split(",");
        LicenseCountDataObject lcObject = new LicenseCountDataObject();
        lcObject.setId(splitColumns[0]);
        lcObject.setLicenseCount(splitColumns[3]);
        return lcObject;
    }
});
```

```
JavaRDD<String> textRDD = javaSparkContext.textFile("file:///Users/apple/simple_text_file.txt");
JavaRDD<String> wordsFlattenedRDD = textRDD.flatMap(new FlatMapFunction<String, String>() {

    @Override
    public Iterable<String> call(String input) throws Exception {
        return Arrays.asList(input.split(" "));
    }
});
```

map transformation - Scala

```
val config = new SparkConf()
config.setAppName("Transformations").setMaster("local[4]")

val sc = new SparkContext(config)

val uidRDD = sc.textFile("D:\\ac\\data\\legacy_uid.csv")
    .map(eachLine => Uid(eachLine))

case class Uid(uidNumber : String)
```

SparkTransformations.scala

distinct() transformation

```
JavaRDD<String> locRDD = javaSparkContext.parallelize(locationList);
```

```
JavaRDD<String> distinctRDD = locRDD.distinct();
```

```
distinctRDD.foreach((outParam) -> System.out.println(outParam));
```

cartesian and pipe transformation

A cartesian operation returns a PairRDD of the two types of rdd's that has to be combined.

The pipe operation executes a linux shell command. The output of the linux command is obtained as a JavaRDD<String>.

cartesian and pipe

```
JavaPairRDD<String, String> countryAndCommodity = countryRDD.cartesian(commodityRDD);  
countryAndCommodity.foreach(param -> System.out.println(param._1 + " " + param._2));
```

```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/apple/undata1.csv");  
rdd.pipe("ls -l").foreach(param -> System.out.println(param));
```

sample

transformation

```
javaSparkContext.textFile("file:///Users/apple/titanic3.csv")
    .sample(false, 0.1)
    .foreach(param -> System.out.println(param));
```

false/true - tends to withReplacement factor.

When a population element can be selected more than one time, we are sampling with replacement.

When a population element can be selected only one time, we are sampling without replacement.

sample

transformation

withReplacementFactor it uses **Poisson Sampler Algorithm**.

withoutReplacementFactor it uses **Bernoulli Sampler Algorithm**.

sample() returns a PartitionwiseSampledRDD as the result.

union and intersection transformation

```
JavaRDD<String> indiaRDD = javaSparkContext.textFile("file:///Users/apple/undata1.csv")
    .filter(param -> param.split(",")[0].toString().equals("\\"India\"));
```

```
JavaRDD<String> hungaryRDD = javaSparkContext.textFile("file:///Users/apple/undata1.csv")
    .filter(param -> param.split(",")[0].toString().equals("\\"Hungary\"));
```

```
indiaRDD.union(hungaryRDD).foreach(param -> System.out.println(param));
```

```
JavaRDD<String> indiaRDDCode = javaSparkContext.textFile("file:///Users/apple/undata1.csv")
    .map(param -> param.split(",")[2].toString());
```

```
JavaRDD<String> hungaryRDDCode = javaSparkContext.textFile("file:///Users/apple/undata1.csv")
    .map(param -> param.split(",")[2].toString());
```

```
indiaRDDCode.intersection(hungaryRDDCode).foreach(param -> System.out.println(param));
```

repartition() and coalesce() transformation

repartition: Reshuffles the data in the RDD to create more or fewer(less) number of partitions.

coalesce(n): Decrease the number of partitions to n.

After filtering a large dataset then coalesce may be useful to reduce the number of partitions. The difference between a repartition and coalesce is that coalesce avoids a full shuffle.

If you are decreasing the number of partitions, then use coalesce. If you are increasing the number of partitions then use repartition.

repartition() and coalesce() transformation

```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/apple/undata1.csv");
    JavaRDD<String> countryRDD = rdd.map(new Function<String, String>() {

        @Override
        public String call(String input) throws Exception {

            String[] splitColumns = input.split(",");
            return splitColumns[0];

        }
    });
}
```

```
JavaRDD<String> repartitionedRDD = countryRDD.repartition(100);
```

```
JavaRDD<String> coalesceRDD = countryRDD.coalesce(5);
```

repartition() and coalesce() transformation

```
def repartition(numPartition) {  
    coalesce(numPartitions, shuffle = true)  
}
```

```
def coalesce(numPartitions: Int, shuffle: Boolean = false)
```

Internally repartition calls in coalesce with a shuffle true.

zip() transformation

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);

JavaRDD<String> first = javaSparkContext.textFile("file:///Users/apple/titanic3.csv");
JavaRDD<String> second = javaSparkContext.textFile("file:///Users/apple/titanic3.csv");

JavaPairRDD<String, String> zippedRDD = first.zip(second);
zippedRDD.foreach(param -> System.out.println(param._1 + " *** " + param._2));
```

zip() transformation

```
3,0,"Lockyer, Mr. Edward","male",,0,0,"1222",7.8792,, "S",,"153", *** 3,0,"Lockyer, Mr.  
Edward","male",,0,0,"1222",7.8792,, "S",,"153",  
3,0,"Lovell, Mr. John Hall (""Henry""),"male",20.5,0,0,"A/5 21173",7.2500,, "S",,, *** 3,0,"Lovell, Mr. John Hall  
(""Henry""),"male",20.5,0,0,"A/5 21173",7.2500,, "S",,,  
3,1,"Lulic, Mr. Nikola","male",27,0,0,"315098",8.6625,, "S",,"15",, *** 3,1,"Lulic, Mr.  
Nikola","male",27,0,0,"315098",8.6625,, "S",,"15",,  
3,0,"Lundahl, Mr. Johan Svensson","male",51,0,0,"347743",7.0542,, "S",,, *** 3,0,"Lundahl, Mr. Johan  
Svensson","male",51,0,0,"347743",7.0542,, "S",,,  
3,1,"Lundin, Miss. Olga Elida","female",23,0,0,"347469",7.8542,, "S",,"10",, *** 3,1,"Lundin, Miss. Olga  
Elida","female",23,0,0,"347469",7.8542,, "S",,"10",,  
3,1,"Lundstrom, Mr. Thure Edvin","male",32,0,0,"350403",7.5792,, "S",,"15",, *** 3,1,"Lundstrom, Mr. Thure  
Edvin","male",32,0,0,"350403",7.5792,, "S",,"15",,  
3,0,"Lyntakoff, Mr. Stanko","male",,0,0,"349235",7.8958,, "S",,, *** 3,0,"Lyntakoff, Mr. Stanko","male",,0,0,"349235",7.8958,, "S",,,
```

zip() transformation

```
3,0,"Lockyer, Mr. Edward","male",,0,0,"1222",7.8792,, "S",,"153", *** 3,0,"Lockyer, Mr.  
Edward","male",,0,0,"1222",7.8792,, "S",,"153",  
3,0,"Lovell, Mr. John Hall (""Henry""),"male",20.5,0,0,"A/5 21173",7.2500,, "S",,, *** 3,0,"Lovell, Mr. John Hall  
(""Henry""),"male",20.5,0,0,"A/5 21173",7.2500,, "S",,,  
3,1,"Lulic, Mr. Nikola","male",27,0,0,"315098",8.6625,, "S",,"15",, *** 3,1,"Lulic, Mr.  
Nikola","male",27,0,0,"315098",8.6625,, "S",,"15",,  
3,0,"Lundahl, Mr. Johan Svensson","male",51,0,0,"347743",7.0542,, "S",,, *** 3,0,"Lundahl, Mr. Johan  
Svensson","male",51,0,0,"347743",7.0542,, "S",,,  
3,1,"Lundin, Miss. Olga Elida","female",23,0,0,"347469",7.8542,, "S",,"10",, *** 3,1,"Lundin, Miss. Olga  
Elida","female",23,0,0,"347469",7.8542,, "S",,"10",,  
3,1,"Lundstrom, Mr. Thure Edvin","male",32,0,0,"350403",7.5792,, "S",,"15",, *** 3,1,"Lundstrom, Mr. Thure  
Edvin","male",32,0,0,"350403",7.5792,, "S",,"15",,  
3,0,"Lyntakoff, Mr. Stanko","male",,0,0,"349235",7.8958,, "S",,, *** 3,0,"Lyntakoff, Mr. Stanko","male",,0,0,"349235",7.8958,, "S",,,
```

glom() transformation

Returns an RDD by fetching all elements within each partition to an array.

or in other words

Returns an RDD which contain array of elements.

Used mostly on matrix manipulations.

Used heavily on statistics and machine learning.

glom() transformation

```
sc.textFile("D:\\ac\\data\\sample.csv")
    .glom()
    .foreach(eachArray =>
        eachArray.foreach(line => println(line)) )
```

SparkGlom.scala

take, first, count, collect

Actions

take(n) returns array with first n elements

first returns first element. Nothing but take(1)

count returns the count.

collect returns the result to the driver program. Always return a small amount of data.

foreach() iterates on an RDD.

take and collect action

```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/apple/undata1.csv");
List<String> firstFiveRows = rdd.take(5);
firstFiveRows.forEach(z -> System.out.println(z));
```



Remember, take()
and collect() return
list of the objects.
They don't return
RDD's.



```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/apple/undata1.csv");
rdd.collect().forEach(z -> System.out.println(z));
```

first and count action

```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/apple/undata1.csv");
```

```
String firstRow = rdd.first();  
System.out.println(firstRow);
```

```
List<String> firstOneRow = rdd.take(1);  
firstOneRow.forEach(z -> System.out.println(z));
```

```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/apple/undata1.csv");  
long totalCount = rdd.count();  
System.out.println(totalCount);
```

foreach action

```
javaSparkContext.textFile("file:///Users/apple/titanic3.csv")
    .foreach(z -> System.out.println(z));
```

```
javaSparkContext.textFile("file:///Users/apple/titanic3.csv")
    .foreach(System.out::println);
```

saveAsTextFile() and saveAsObjectFile() Action

saveAsTextFile()

Writes data to the directory of file system. Spark uses `toString()` method on each object and stores it to disk.

```
rdd.saveAsTextFile("/Users/apple/saver002");
```

saveAsObjectFile()

Write the element as an object file to the file system using simple java serialization. The file saved can be loaded using `SparkContext.objectFile()`.

```
rdd.saveAsObjectFile("/Users/apple/saverzz");
```

```
| Apples-MacBook-Pro:~ apple$ ls saverzz/  
| _SUCCESS          part-00000      part-00001
```

saveAsTextFile() and saveAsObjectFile() Action

After saving the data to the file system, the data can be loaded to spark by SparkContext.objectFile() as shown below.

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);
JavaRDD<UNDataBean> lcRDD = javaSparkContext.objectFile("/Users/apple/saverzz");
```

saveAsSequenceFile() Action

Writes the data as a Hadoop SequenceFile.

A Hadoop SequenceFile is a binary key value pair based file.
saveAsSequenceFile() is supported only on a pair rdd.

```
val sparkSession = SparkSession .builder()  
    .appName("SparkJOB")  
    .master("local")  
    .getOrCreate
```

```
val sparkContext = sparkSession.sparkContext
```

```
sparkContext.textFile("file:///home/aad-pc1/insurance.csv")  
    .map(x => (x.split(",")(0),x.split(",")(1)))  
    .saveAsSequenceFile("file:///home/aad-pc1/insurance_sequence.c
```

```
@InterfaceAudience.Public  
@InterfaceStability.Stable  
public class SequenceFile  
extends Object
```

SequenceFiles are flat files consisting of binary key/value pairs.
SequenceFile provides SequenceFile.Writer, SequenceFile.Reader and
SequenceFile.Sorger classes for writing, reading and sorting respectively.

There are three SequenceFile Writers based on the SequenceFile.CompressionType
used to compress key/value pairs:

1. Writer : Uncompressed records.
2. RecordCompressWriter : Record-compressed files, only compress values.
3. BlockCompressWriter : Block-compressed files, both keys & values are
collected in 'blocks' separately and compressed. The size of the 'block' is
configurable.

The actual compression algorithm used to compress key and/or values can be specified
by using the appropriate [CompressionCodec](#).

The recommended way is to use the static createWriter methods provided by the
SequenceFile to chose the preferred format.

The SequenceFile.Reader acts as the bridge and can read any of the above
SequenceFile formats.

saveAsSequenceFile() Action

```
aad-pc1@AAD-PC1: ~/Insurance_sequence.csv
[1] 119736 FL 00000
[2] 448994 FL 00000
[3] 206893 FL 00000
[4] 333743 FL 00000
[5] 172534 FL 00000
[6] 785275 FL 00000
[7] 999592 FL 00000
[8] 223486 FL 00000
[9] 433512 FL 00000
[10] 142071 FL 00000
[11] 253816 FL 00000
[12] 894922 FL 00000
[13] 422834 FL 00000
[14] 582721 FL 00000
[15] 842700 FL 00000
[16] 874333 FL 00000
[17] 580146 FL 00000
[18] 456149 FL 00000
[19] 767862 FL 00000
[20] 353022 FL 00000
[21] 367814 FL 00000
[22] 671392 FL 00000
[23] 772887 FL 00000
[24] 983122 FL 00000
[25] 934215 FL 00000
[26] 385951 FL 00000
[27] 716332 FL 00000
[28] 751262 FL 00000
[29] 633663 FL 00000
[30] 105851 FL 00000
[31] 710400 FL 00000
[32] 703061 FL 00000
[33] 352792 FL 00000
[34] 717603 FL 00000
[35] 937659 FL 00000
[36] 294022 FL 00000
[37] 410500 FL 00000
[38] 524433 FL 00000
[39] 779298 FL 00000
[40] 491831 FL 00000
[41] 814637 FL 00000
[42] 737515 FL 00000
[43] 222653 FL 00000
[44] 788543 FL 00000
[45] 691681 FL 00000
[46] 368807 FL 00000
[47] 174002 FL 00000
[48] 198760 FL 00000
[49] 831395 FL 00000
[50] 305694 FL 00000
[51] 515722 FL 00000
[52] 415582 FL 00000
[53] 783533 FL 00000
[54] 640802 FL 00000
[55] 403866 FL 00000
[56] 828788 FL 00000
"part-00000" [neo4j][converted] 36635L, 670317C
```

StatCounter - Statistical info on Numerical Data

```
val rdd = sparkContext.parallelize(List(100,  
    200,  
    300,  
    400,  
    500))
```

The statcounter acts on a RDD and gives numerical computation on the data.

```
val max = rdd.stats().max  
val min = rdd.stats().min  
val mean = rdd.stats().mean  
val variance = rdd.stats().variance  
  
println(min + " " + max + " " + mean + " " + variance)
```

The data on the RDD should be numerical data for StatCounter to be acted upon.

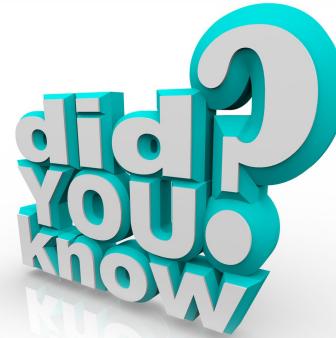
org.apache.spark.util.StatCounter

Spark Packages

<http://spark-packages.org/>



Contains all open source libraries which are not shipped as the part of official distribution.



PairRDD - Creation

- map()
- mapToPair()
- keyBy()
- flatMapValues()

PairRDD - Operations

- reduceByKey()
- countByKey()
- groupByKey()
- sortByKey()

PairRDD - Creation map()

- Constructs a two component tuples.

```
val sparkSession = SparkSession.builder()
    .appName("SparkJOB")
    .master("local")
    .getOrCreate

val sparkContext = sparkSession.sparkContext

val pairRDD = sparkContext.textFile("file:///home/aad-pc1/insurance.csv")
    .map(x => (x.split(",")(0),x.split(",")(1)))
    .foreach(x => println(x._1 + " " + x._2))
```

x. 1 will have the code

x._2 will have the country code

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PairRDD - Creation

keyBy()

- Constructs a two component tuples.
 - First key has the result of the function logic written inside the keyBy and the value has the original data

```
val sparkSession = SparkSession.builder()
    .appName("SparkJOB")
    .master("local")
    .getOrCreate

val sparkContext = sparkSession.sparkContext

sparkContext.textFile("file:///home/aad-pc1/insurance.csv")
    .keyBy((x) => x.split(",")(2))
    .map(x => println(x._1) )
    .collect()
```

x._1 will have the country name
x._2 will have the entire data.

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PairRDD - Actions

1. lookup()
2. collectAsMap()
3. countByKey()

```
val out = sparkContext.textFile("file:///home/aad-pc1/insurance.csv")
    .map(x => (x.split(",")(0),x.split(",")(1)))
    .lookup("742303")
```

```
val out1 = sparkContext.textFile("file:///home/aad-pc1/insurance.csv")
    .map(x => (x.split(",")(0),x.split(",")(1)))
    .collectAsMap()
```

```
val out2 = sparkContext.textFile("file:///home/aad-pc1/insurance.csv")
    .map(x => (x.split(",")(0),x.split(",")(1)))
    .countByKey()
```

PairRDD - Creation

mapToPair()

```
JavaRDD<LatLong> locRDD = javaSparkContext.parallelize(locationList);
```

```
JavaPairRDD<Integer, LatLong> pairRDD = locRDD.mapToPair(new PairFunction<LatLong, Integer, LatLong>() {
```

```
    @Override  
    public Tuple2<Integer, LatLong> call(LatLong latLong) throws Exception {  
        return new Tuple2<>(new Integer(latLong.getId()), latLong);  
    }  
});
```

```
pairRDD.foreach((z) -> System.out.println(z._1.intValue() + " - " + z._2.getName()));
```

PairRDD - Creation

keyBy()

```
JavaRDD<LatLong> locRDD = javaSparkContext.parallelize(locationList);
```

```
JavaPairRDD<Integer, LatLong> pairRDD_KeyBy_ = locRDD.keyBy(new Function<LatLong, Integer>() {
```

```
    @Override
```

```
    public Integer call(LatLong v1) throws Exception {
```

```
        return new Integer(v1.getId());
```

```
    }
```

```
});
```

```
pairRDD_KeyBy_.foreach((z) -> System.out.println(z._1.intValue() + " --- " + z._2.getName()));
```

PairRDD - Creation

flatMapValues()

flatMapValues() transformation:

The flatMapValues can be performed over only on PairRDD's

```
JavaPairRDD<Integer, String> flatMapValuesRDD = pairRDD
    .flatMapValues(new Function<LatLong, Iterable<String>>()
{
    @Override
    public Iterable<String> call(LatLong latLong) throws Exception {
        return Arrays.asList(latLong.getLatitude(), latLong.getLongitude(), latLong.getName());
    }
});
```

PairRDD - Operations

reduceByKey()

```
JavaPairRDD<String, Integer> reduceByKeyRDD =  
  
    javaSparkContext.parallelize(listOfNames)  
        .mapToPair  
            (param -> new Tuple2<>(String.valueOf(param.charAt(0)), new Integer(1)))  
        .reduceByKey  
            ((param1, param2) -> new Integer(param1.intValue() + param2.intValue()));
```

PairRDD - Operations

groupByKey()

```
JavaRDD<String> textRDD = javaSparkContext.textFile("file:///Users/apple/simple_text_file.txt");

textRDD.flatMap(param -> Arrays.asList(param.split(" ")))
    .mapToPair(param -> new Tuple2<String, Integer>(param, 1))
    .groupByKey()
    .foreach((words) -> System.out.println(words._1 + " " + words._2));
```

MLlib [1]

for [1, 1, 1]

computing [1]

an [1]

Scala, [1]

machine [1]

engine [1]

and [1, 1, 1, 1, 1]

supports [1, 1]

PairRDD - Operations

sortByKey()

```
JavaRDD<String> textRDD = javaSparkContext.textFile("file:///Users/apple/simple_text_file.txt");
```

```
textRDD.flatMap(param -> Arrays.asList(param.split(" ")))
    .mapToPair(param -> new Tuple2<String, Integer>(param, 1))
    .sortByKey()
    .foreach((words) -> System.out.println(words._1 + " " + words._2));
```

fast 1
APIs 1
for 1
Apache 1
for 1
GraphX 1
for 1

PairRDD - Operations

countByKey()

```
JavaRDD<String> textRDD = javaSparkContext.textFile("file:///Users/apple/simple_text_file.txt");

Set<Entry<String, Object>> values = textRDD.flatMap(param -> Arrays.asList(param.split(" ")))
    .mapToPair(param -> new Tuple2<String, Integer>(param, 1))
    .countByKey()
    .entrySet();

values.forEach(param -> System.out.println(param.getKey() + " " + param.getValue()));
```

Note: countByKey() is an action.

PairRDD - Operations

countByKey()

countByKey internally calls reduceByKey and then collect and converts to a map.

reduceByKey(_ + _).collect().toMap

So countByKey should not be used for large datasets. Since this API will load everything to the driver's memory.

Performance Improvement

PairRDD - Operations

countByKey()

Instead of countByKey() use

```
rdd.mapValues(_ => 1L).reduceByKey(_ + _)
```

for large datasets.

Performance Improvement

Word count in Spark

```
SparkConf sparkConfig = new SparkConf()
    .setAppName("WordCountSparkExample")
    .setMaster("local[8]");

JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);

JavaRDD<String> textRDD = javaSparkContext.textFile("file:///Users/apple/simple_text_file.txt");

JavaRDD<String> wordsFlattenedRDD = textRDD.flatMap(new FlatMapFunction<String, String>() {

    @Override
    public Iterable<String> call(String input) throws Exception {
        return Arrays.asList(input.split(" "));
    }
});
```

Word count in Spark

```
JavaPairRDD<String, Integer> pairWordMapperRDD = wordsFlattenedRDD.mapToPair(new PairFunction<String, String, Integer>() {  
  
    @Override  
    public Tuple2<String, Integer> call(String inputWord) throws Exception {  
  
        return new Tuple2<String, Integer>(inputWord, 1);  
    }  
  
});  
  
JavaPairRDD<String, Integer> countedWords = pairWordMapperRDD.reduceByKey(new  
Function2<Integer, Integer, Integer>() {  
  
    @Override  
    public Integer call(Integer arg0, Integer arg1) throws Exception {  
        return new Integer(arg0 + arg1);  
    }  
});  
  
countedWords.foreach((words) -> System.out.println(words._1 + words._2));
```

Word count in Spark

```
textRDD.flatMap(param -> Arrays.asList(param.split(" ")))  
    .mapToPair(param -> new Tuple2<String, Integer>(param, 1))  
    .reduceByKey((integerParam1, integerParam2) -> new  
                Integer(integerParam1 + integerParam2))  
    .foreach((words) -> System.out.println(words._1 + " " + words._2));
```

Word count in Spark - Scala

```
object WordCountSpark extends App {  
  
    val config = new SparkConf  
    config.setAppName("WordCount")  
    config.setMaster("local[4]")  
  
    val sc = new SparkContext(config)  
  
    sc.textFile("D:/ac/data/Simple_Text_File.txt").flatMap(line => line.split(" "))  
        .map(eachWord => (eachWord,1))  
        .reduceByKey((parameterA,parameterB) => parameterA + parameterB)  
        .foreach(wordcount => println(wordcount._1 + wordcount._2))  
  
    sc.stop()  
  
}
```

Spark Job History Server

Spark Job History Server

To start the job history server use the below command,

sbin/start-history-server.sh

```
SparkConf sparkConfig = new SparkConf()
    .set("spark.eventLog.enabled", "true")
    .set("spark.eventLog.dir", "file:///Users/apple/spark-events")
        // Default is /tmp/spark-events

    .setAppName("ReadUNData")
    .setMaster("local[8]");
```

Note: You need to create the spark-events directory manually.

Spark Job History Server

When the job history server is started, you should see it in the process status

```
Apples-MacBook-Pro:sbin apple$ ./start-history-server.sh
starting org.apache.spark.deploy.history.HistoryServer, logging to /Users/apple/spark14/sbin/../logs/spark-apple-org.apache.spark.deploy.history.HistoryServer-1
Apples-MacBook-Pro.local.out
Apples-MacBook-Pro:sbin apple$ ps -ef | grep spark
 501 2135 144  0 11:08AM ??        1:34.37 /Users/apple/sparktraining/Eclipse.app/Contents/MacOS/eclipse
 501 2224     1  0 11:13AM ttys001    0:02.44 /Library/Java/JavaVirtualMachines/jdk1.8.0_60.jdk/Contents/Home/jre/bin/java -cp /Users/apple/spark14/sbin/../co
nf:/Users/apple/spark14/lib/spark-assembly-1.4.0-hadoop2.6.0.jar:/Users/apple/spark14/lib/datanucleus-api-ido-3.2.6.jar:/Users/apple/spark14/lib/datanucleus-cor
e-3.2.10.jar:/Users/apple/spark14/lib/datanucleus-rdbms-3.2.9.jar -Xms512m -Xmx512m org.apache.spark.deploy.history.HistoryServer
```

Spark Job History Server

Job history server starts in 18080 port by default.

The screenshot shows a web browser window with the URL `localhost:18080` in the address bar. The page title is "History Server" with the "Spark 1.4.0" logo. Below the title, it says "Event log directory: file:/tmp/spark-events". A table header "Showing 1-1 of 1" is followed by a table with one row. The table has columns: App ID, App Name, Started, Completed, Duration, Spark User, and Last Updated. The data in the table is:

App ID	App Name	Started	Completed	Duration	Spark User	Last Updated
local-1443159738356	ReadUNData	2015/09/25 11:12:17	2015/09/25 11:12:19	2 s	apple	2015/09/25 11:12:19

At the bottom left, there is a link "Show incomplete applications".

RDD Lineage

RDD's follow a parent child relationship whereby the child knows its parent.

Each action on the RDD, re-executes the transformation starting from the base.

RDD Lineage helps in fault tolerant behavior of the RDD.

RDD Checkpointing

RDD lineage provides fault tolerance but also can cause problems when the lineage gets long.

Checkpointing saves the data in the disk and solves in RDD lineage issues.

Since the recovery of data can be expensive, checkpointing saves the data to HDFS.

Checkpointing has to be done before any actions on the RDD is taken.

In spark streaming, checkpointing helps in fault tolerant streaming.

RDD Checkpointing

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);
javaSparkContext.setCheckpointDir("/Users/apple/checkpointdir");
```

```
JavaRDD<String> locRDD = javaSparkContext.textFile("file:///Users/apple/titanic3.csv");
```

```
JavaRDD<String> locRDDUnion =
    locRDD.union(locRDD).union(locRDD).union(locRDD).union(locRDD).union(locRDD).union(
    locRDD).union(locRDD).union(locRDD).union(locRDD).union(locRDD).union(locRDD).union(locRDD).;
```

```
locRDDUnion.checkpoint();
```

```
locRDDUnion.foreach((z) -> System.out.println(z));
```

RDD Checkpointing

Use the `isCheckpointed()` method to check if an RDD is checkpointed

```
boolean islocRDDCheckpointed = locRDDUnion.isCheckpointed()
```

```
if (islocRDDCheckpointed) {
```

```
....
```

```
....
```

```
}
```

```
else {
```

```
....
```

```
....
```

```
}
```

When to do RDD Checkpointing

The computation takes a long time.

The RDD lineage chain is long.

The code complexity depends on too many RDD's.

Speculative Execution in Spark

It is an optimization technique adopted by the mapreduce framework.

When a JobTracker finds out that a task takes too much of time to execute, it can start additional instance of the same task.

This process of execution is called **speculative execution**.

Speculative execution ensures that a slowness in a machine will not slow down a task.

Speculative Execution in Spark

By default it is false.

You make it enabled by *spark.speculation* to true.

Accumulators

Accumulators provides a simple way of aggregating values from the worker nodes to the driver program. Accumulators are used for counting in data.

An accumulator is created using a spark-context.

A worker adds a value to the accumulator using the add() method and the driver program calls the accumulator to access its final value.

Worker nodes always write to accumulators and finally the accumulator value is accessed by the driver program.

Accumulators

```
Accumulator<Integer> survivedAccumulator = javaSparkContext.accumulator(0, "survived_accumulator");
Accumulator<Integer> deadAccumulator = javaSparkContext.accumulator(0, "dead_accumulator");
```

```
long totalCount = javaSparkContext.textFile("file:///Users/koteshwar/titanic3.csv")
    .map(new Function<String, String>() {
```

```
        @Override
        public String call(String input) throws Exception {
```

```
            String[] splittedInput = input.split(",");
```

```
            if (splittedInput[1].equals("1"))
                survivedAccumulator.add(new Integer(1));
            else
                deadAccumulator.add(new Integer(1));
```

```
        return splittedInput[1];
    }
```

```
}).count();
```

```
System.out.println("Survived People - " + survivedAccumulator.value());
System.out.println("People Dead - " + deadAccumulator.value());
System.out.println("Total Count - " + totalCount);
```

Accumulator value cannot be accessed inside a worker

```
long totalCount = javaSparkContext.textFile("file:///Users/koteshwar/titanic3.csv")
    .map(new Function<String, String>() {

        @Override
        public String call(String input) throws Exception {

            System.out.println(survivedAccumulator.value());
            .....
            .....
        }
    }
```

```
java.lang.UnsupportedOperationException: Can't read accumulator value in task
    at org.apache.spark.Accumulable.value(Accumulators.scala:97)
```

Custom Accumulator

Implement the accumulator extending the Accumulator Param

```
class UIDAccumulator implements AccumulatorParam<UIDBean> {  
  
    public UIDBean addInPlace(UIDBean first, UIDBean second) {  
  
        UIDBean bean = new UIDBean();  
        bean.setUid(first.getUid() + " - " + second.getUid());  
  
        return bean;  
    }  
  
    public UIDBean zero(UIDBean arg0) {  
        return new UIDBean();  
    }  
  
    public UIDBean addAccumulator(UIDBean first, UIDBean second) {  
  
        UIDBean bean = new UIDBean();  
        bean.setUid(first.getUid() + " - " + second.getUid());  
  
        return bean;  
    } }
```

Java

Custom Accumulator

Second : define the accumulator

```
Accumulator<UIDBean> successAccumulator = javaSparkContext.accumulator(  
    new UIDBean(),  
    "success_uid_accumulator",  
    new UIDAccumulator());
```

```
Accumulator<UIDBean> failureAccumulator = javaSparkContext.accumulator(  
    new UIDBean(),  
    "failure_uid_accumulator",  
    new UIDAccumulator());
```

Custom Accumulator

```
javaSparkContext.textFile("file:///D:/ac/data/legacy uid.csv")
    .map (new Function<String, String>() {
        @Override
        public String call(String input) throws Exception {
            UIDBean uidBean = new UIDBean();
            uidBean.setUid(input);
            if (input.startsWith("28336"))
                successAccumulator.add(uidBean);
            else
                failureAccumulator.add(uidBean);
            return input;
        }
    }).count();
```

```
System.out.println("Successful Aadhaars - " + successAccumulator.value().getUid());
```

Custom Accumulator

```
class UIDBean implements Serializable {  
  
    private String uid = "";  
  
    public String getUid() {  
        return uid;  
    }  
  
    public void setUid(String uid) {  
        this.uid = uid;  
    }  
  
}
```

Java

Custom Accumulator

SCALA

```
implicit object AuthSuccessAccumulator extends AccumulatorParam[AuthSuccess] {  
    override def addInPlace(r1: AuthSuccess, r2: AuthSuccess): AuthSuccess =  
        AuthSuccess(r1.uid + " - " + r2.uid)  
    override def zero(initialValue: AuthSuccess): AuthSuccess = AuthSuccess("")  
}
```

Custom Accumulator

```
object CustomAccumulator extends App {  
  
    val config = new SparkConf  
    config.setAppName("Accumulator")  
    config.setMaster("local[4]")  
  
    val context = new SparkContext(config)  
  
    val successAccumulator = context.accumulator(AuthSuccess("1000"),  
    "SUCCESS_ACCUMULATOR")  
  
    context.textFile("D:/ac/data/legacy_uid.csv").map(x =>  
  
        if (x.startsWith("28336"))  
            successAccumulator.add(AuthSuccess(x))  
  
    ).collect()  
  
    println(successAccumulator.value)  
}  
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```

SCALA

Broadcast Variables

Broadcast variable allows a program to send in read-only value objects to all worker nodes.

A broadcast variable is an object of type `org.apache.spark.broadcast.Broadcast` which wraps a custom object.

The broadcast-variable allows spark to efficiently transfer data to all worker nodes.

Broadcast variables minimizes the data transfer over the network. The value is sent to each node only once.

Broadcast Variables

```
import org.apache.spark.broadcast.Broadcast;

Broadcast<TitanicBean> bc = javaSparkContext.broadcast(new TitanicBean("1", "1", "William"));

long totalCount = javaSparkContext.textFile("file:///Users/koteshwar/titanic3.csv")
    .map(new Function<String, String>() {

        @Override
        public String call(String input) throws Exception {
            String[] splittedInput = input.split(",");
            TitanicBean titanicBean = bc.getValue();

            System.out.println(titanicBean.getName());
            return splittedInput[1];
        }
    }).count();
```

Spark Internals

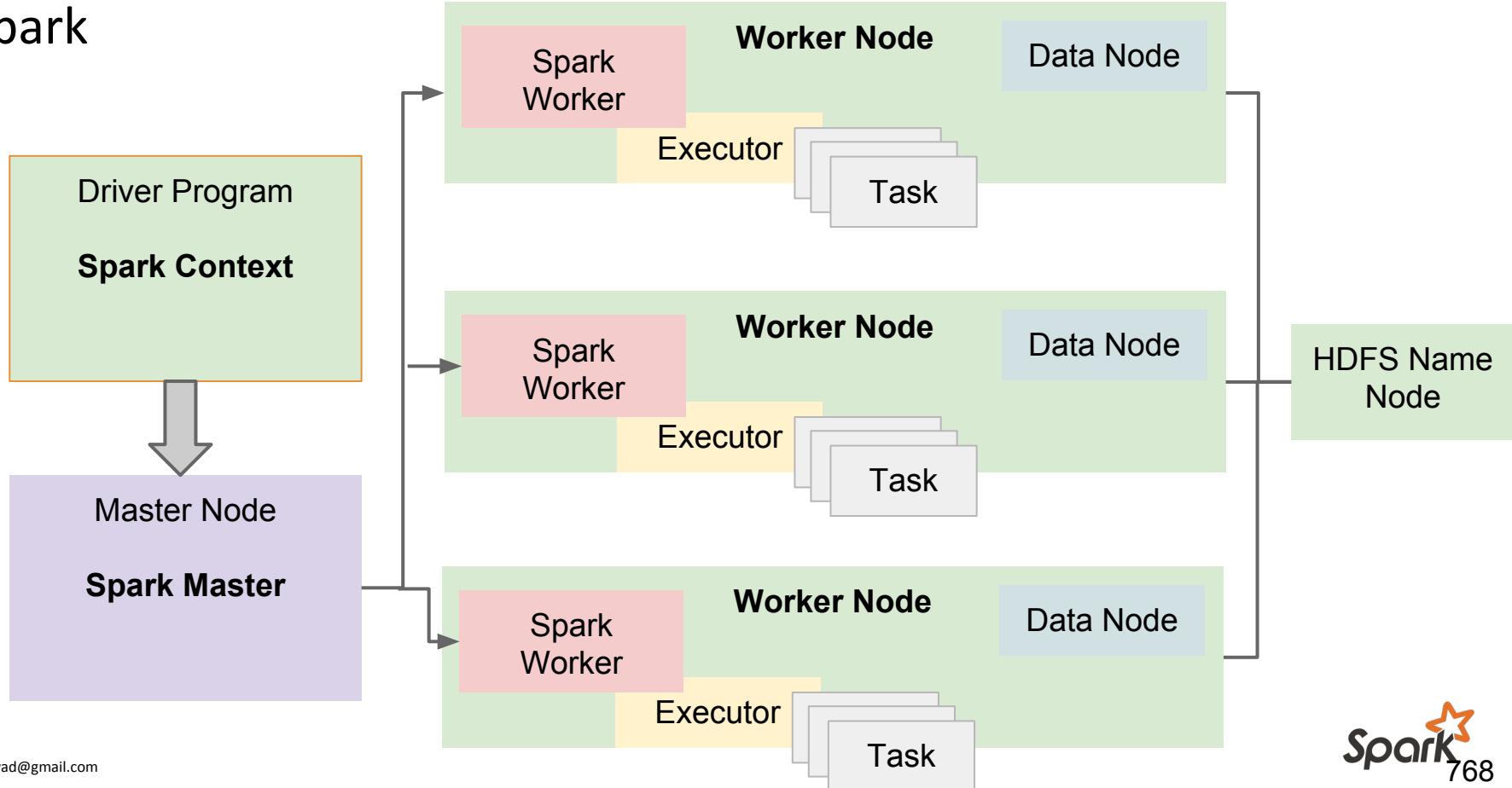
Driver Program: The main program which creates the Spark Context (sc)

Master: Spark cluster runs in the master node. Spark comes with its own cluster manager or can run on Mesos/YARN.

Workers: A node which runs application code on the cluster

Executors: Executor is the program that is launched on the workers when a job is submitted. Each application has its own executors.

The Driver program, the master, the workers and the tasks of spark

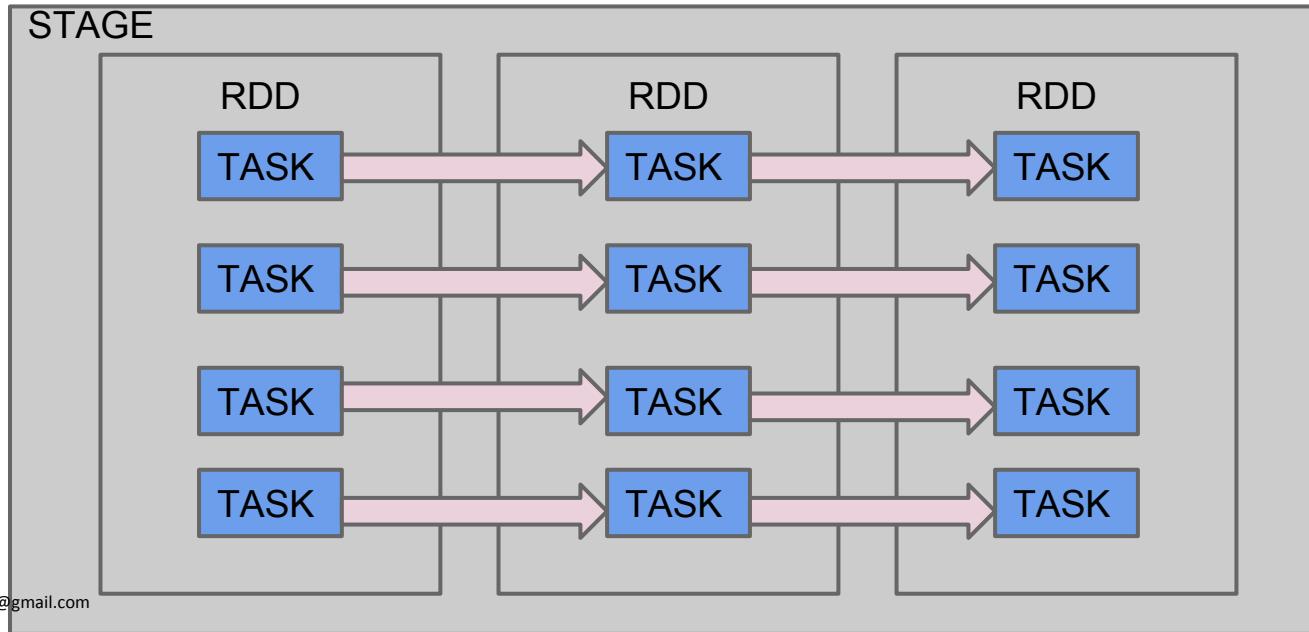


Spark Internals - Job, Stage and Task

Job a set of tasks executed as a result of an action

Stage a set of tasks in a job that can be executed in parallel

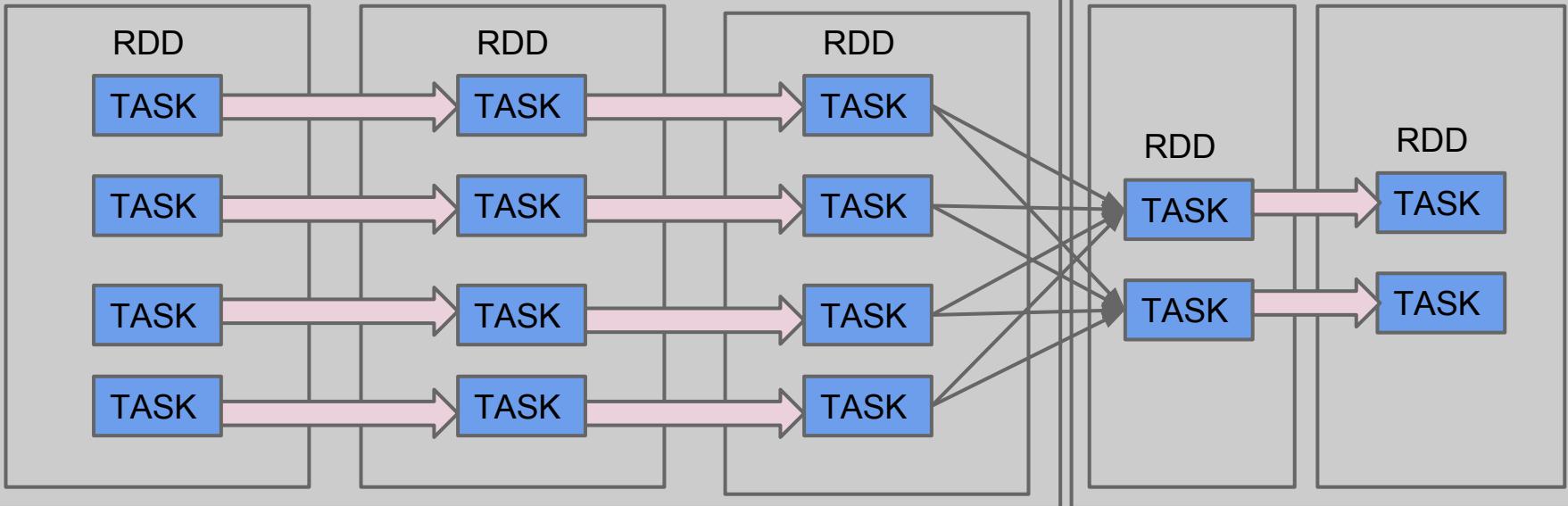
Task an individual unit of work sent to one executor



Spark Internals - Job, Stage and Task

JOB

STAGE



Spark Internals - Job, Stage and Task

RDD's are stored in memory of the Spark Executor JVM's

RDD operations are executed on partitions in parallel.

Operations that depend on the same partition are pipelined together in stages.

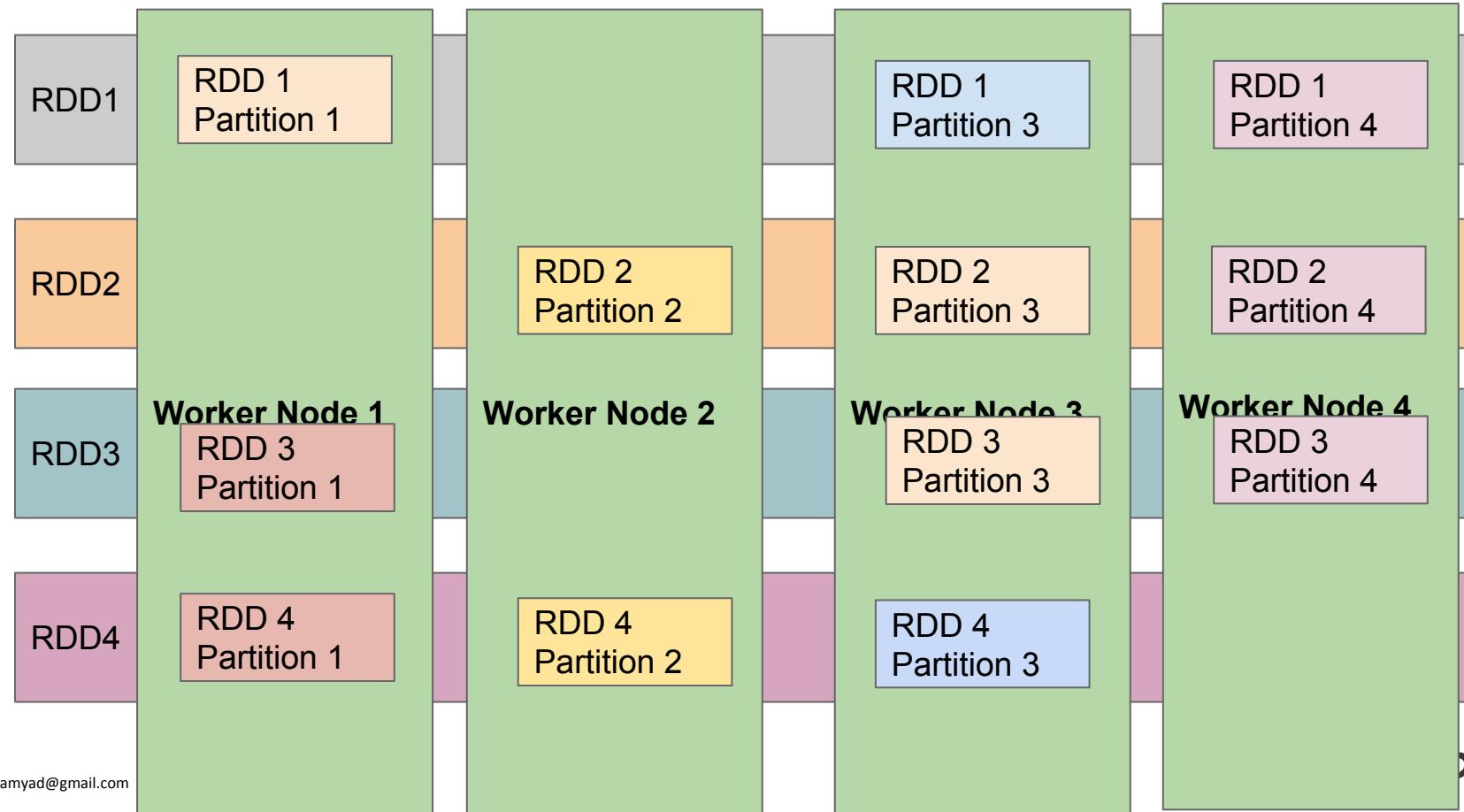
Operations that depend on multiple partitions are executed in separate stages.

Number of Tasks = Number of Partitions

Tasks within a stage are pipelined together.

Operations that can run on the same partition are executed in stages.
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Spark Partition

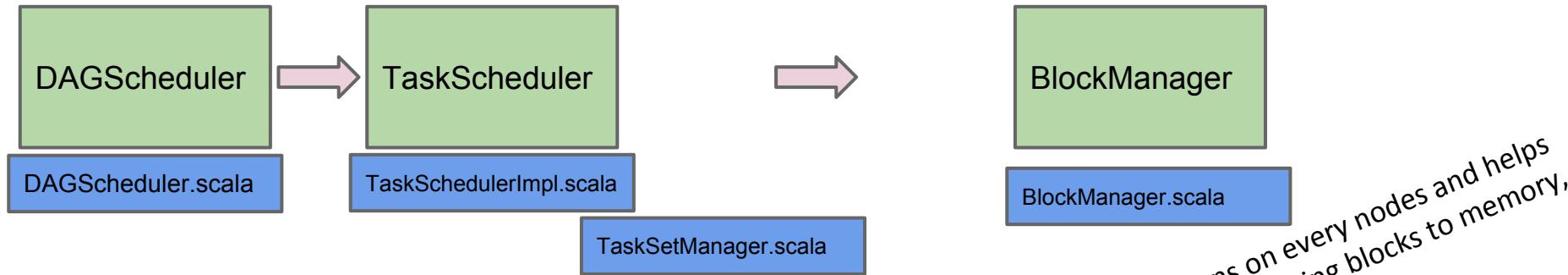


Spark Internals - Job, Stage and Task

By default, spark creates one partition for each block of file.

Here, block meaning to one HDFS block. (ie., 64 MB by default).

Spark Internals - DAG



DAGScheduler computes a DAG of stages for each job.

Number of times that a task will be attempted in a stage can be configured on `spark.task.maxFailures`, default is 4.

Spark Internals

Spark 1.4.0

Jobs Stages Storage Environment Executors

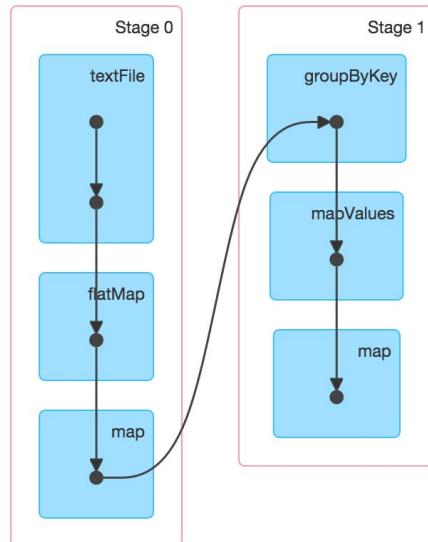
Details for Job 0

Status: RUNNING

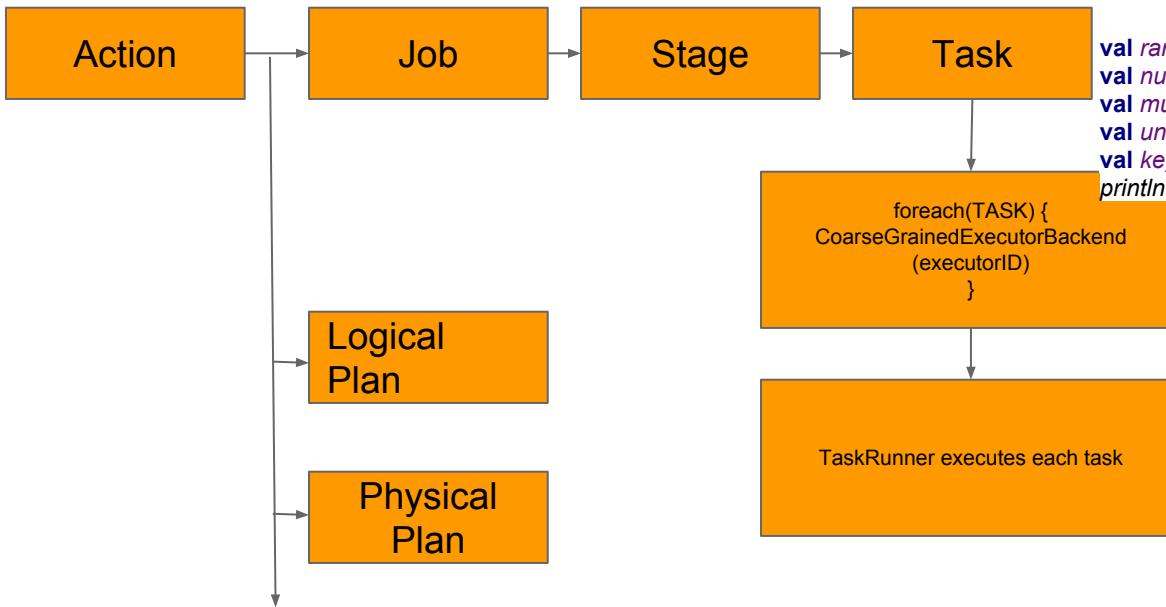
Active Stages: 1

Completed Stages: 1

- ▶ Event Timeline
- ▼ DAG Visualization



Spark Internals



```
val rangeOfNumbers = 1 to 100
val numberRDD = sparkContext.parallelize(rangeOfNumbers)
val multipliedRDD = numberRDD.map(x => x*2)
val unionRDD = numberRDD.union(multipliedRDD)
val keyValueUnionRDD = unionRDD.map(x=> (x,x))
println(keyValueUnionRDD.toDebugString)
```

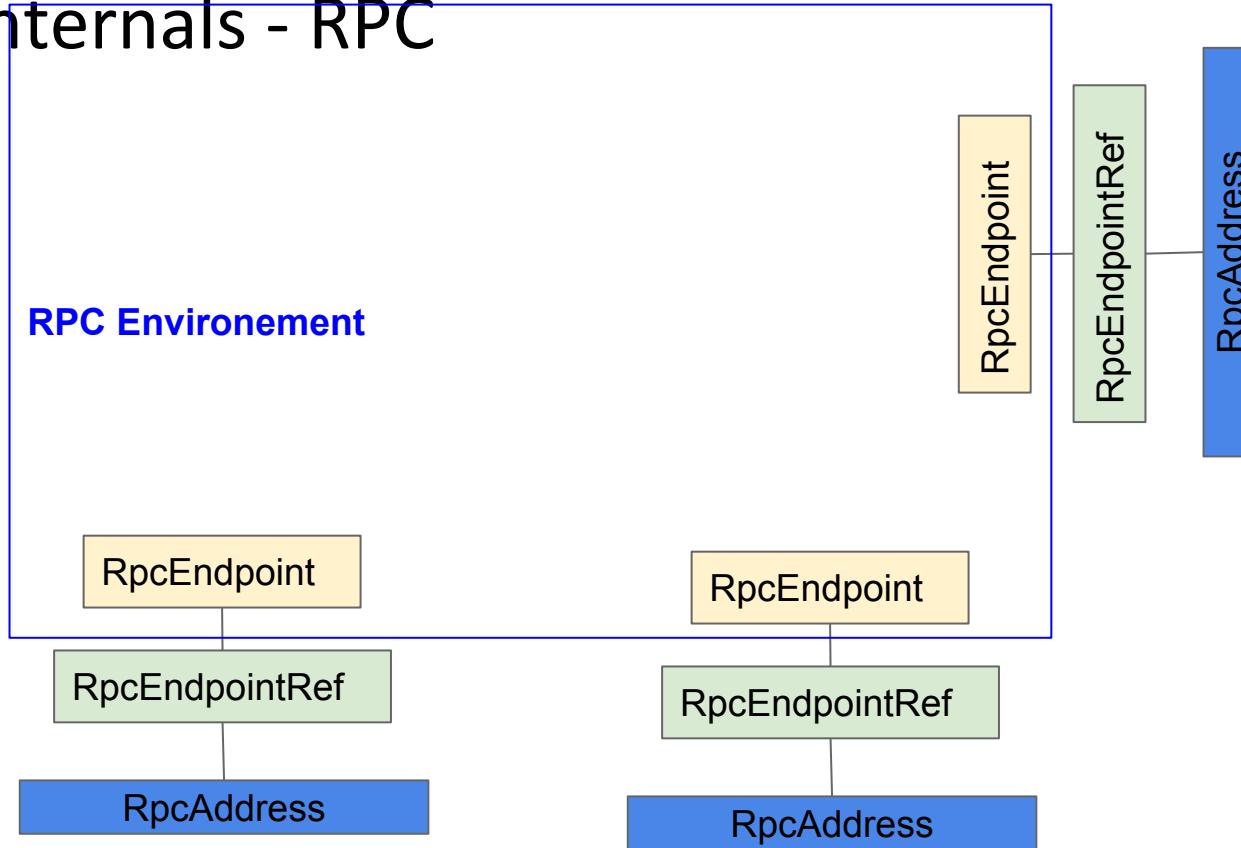
Spark Internals

The screenshot shows the Spark UI interface for a "ReadFile application UI". The top navigation bar includes links for Jobs (which is selected), Stages, Storage, Environment, and Executors. The main content area displays "Details for Job 0". Key metrics shown are Status: RUNNING, Active Stages: 1, and Completed Stages: 1. There are links for Event Timeline and DAG Visualization. Two tables are present: "Active Stages (1)" and "Completed Stages (1)". The "Active Stages" table has one row with Stage Id 1 and Description "count at SparkInternals.java:43". The "Completed Stages" table has one row with Stage Id 0 and Description "mapToPair at SparkInternals.java:26". Both tables include columns for Stage Id, Description, +details, Submitted (2015/09/20 10:04:12), Duration (1.2 min for active, 97 ms for completed), Tasks: Succeeded/Total (0/2 for active, 2/2 for completed), Input (1063.0 B), Output, Shuffle Read, and Shuffle Write.

Stage Id	Description	+details	Submitted	Duration	Tasks: Succeeded/Total	Input	Output	Shuffle Read	Shuffle Write
1	count at SparkInternals.java:43	(kill)	2015/09/20 10:04:12	1.2 min	0/2			1063.0 B	

Stage Id	Description	+details	Submitted	Duration	Tasks: Succeeded/Total	Input	Output	Shuffle Read	Shuffle Write
0	mapToPair at SparkInternals.java:26		2015/09/20 10:04:12	97 ms	2/2	407.0 B			1063.0 B

Spark Internals - RPC



Spark Internals - RPC

Two RPC Implementations of Rpc is supported by spark

Netty

Akka

Netty - org.apache.spark.rpc.netty.NettyRpcEnvFactory

Akka - org.apache.spark.rpc.akka.AkkaRpcEnvFactory

This can be set in the config `spark.rpc` (either `netty` or `akka`, default is `netty`)

`--config spark.rpc = netty`

Custom RDD

Creating our own RDD by adding custom functionalities to it.

One way of extending Spark API

To implement extend the RDD class and override
`getPartitions` and `compute()` methods.

Custom RDD

```
class LegitimateBiometricRDD(biometricBeanRDD : RDD[BiometricBean]) extends  
RDD[BiometricBean](biometricBeanRDD) {  
  
override def compute(split: Partition, context: TaskContext): Iterator[BiometricBean]  
= {  
  
    firstParent[BiometricBean].iterator(split, context).map(eachRecord => {  
        val fuzzyScore = eachRecord.fuzzyScore  
  
        if (fuzzyScore > 6)  
            BiometricBean(eachRecord.irisTemplate, eachRecord.handTemplate,  
"LEGITIMATE BIOMETRIC", 10)  
        else  
            BiometricBean(eachRecord.irisTemplate, eachRecord.handTemplate,  
"BIO_METRIC SCORE INSUFFICIENT", 0)  
  
    })  
}  
  
override protected def getPartitions: Array[Partition] = {  
    firstParent[BiometricBean].partitions  
}  
}
```

Custom RDD

```
val sc = new SparkContext(config)
val biometricRDD = sc.parallelize(dataSource)

/*
  Using LegitimateBiometricRDD
*/
val legitimateBiometricRDD = new LegitimateBiometricRDD(biometricRDD)
legitimateBiometricRDD.foreach(biometricRecord =>
  println(biometricRecord.fuzzyScore + " - " + biometricRecord.errorCode))

case class BiometricBean(irisTemplate : String,
                        handTemplate : String,
                        errorCode : String,
                        fuzzyScore : Int)
```

CustomRDD.scala

Spark RDD

Logical Plan

Logical plan is nothing but the Data Dependency Graph. `rdd.toDebugString()` returns the logical plan.

Physical Plan

Physical plan is the Directed Acyclic Graph.

After the physical plan, concrete tasks are generated.

Spark RDD - Logical Plan

```
JavaPairRDD<String, Integer> reducedRDD =  
    textRDD.flatMap(param -> Arrays.asList(param.split(" ")))  
        .mapToPair(param -> new Tuple2<String, Integer>(param, 1))  
        .reduceByKey((integerParam1, integerParam2) -> new Integer(integerParam1 +  
integerParam2));  
  
System.out.println(reducedRDD.toDebugString());
```

Output:

```
(2) ShuffledRDD[4] at reduceByKey at WordCountUsingSpark.java:71 []  
+-(2) MapPartitionsRDD[3] at mapToPair at WordCountUsingSpark.java:70 []  
| MapPartitionsRDD[2] at flatMap at WordCountUsingSpark.java:69 []  
| MapPartitionsRDD[1] at textFile at WordCountUsingSpark.java:26 []  
| file:///Users/apple/simple_text_file.txt HadoopRDD[0] at textFile at WordCountUsingSpark.java:26 []
```

Spark Memory Model

`spark.storage.memoryFraction`

`spark.storage.unrollFraction`

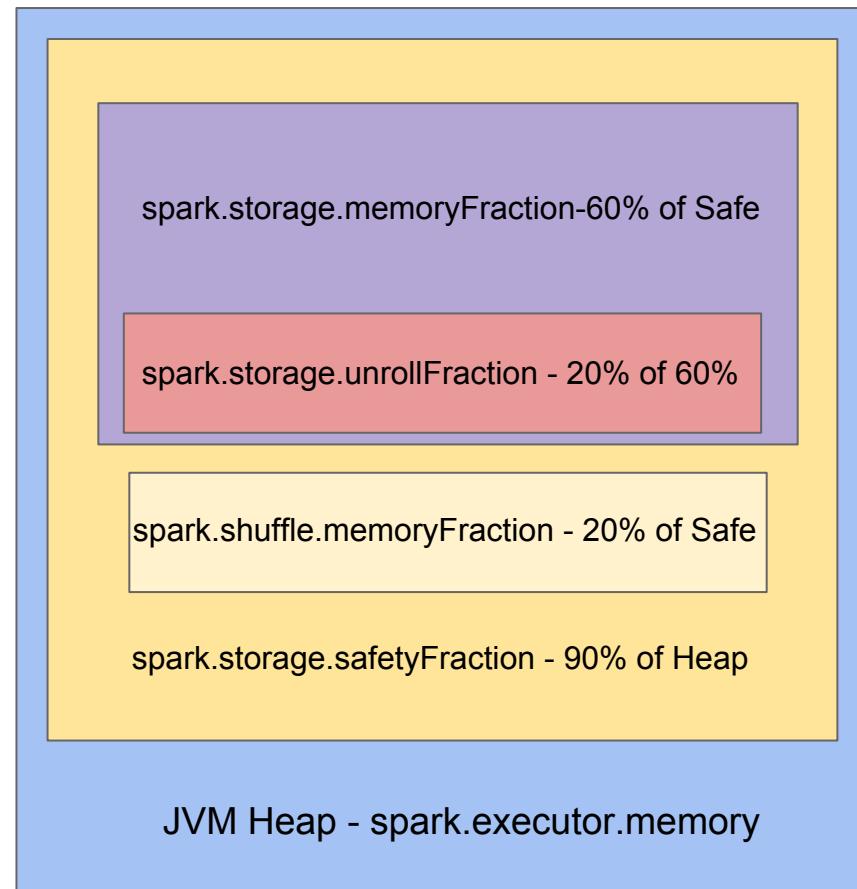
Serialize/Deserialize objects
to disk when they don't fit in memory.

`spark.shuffle.memoryFraction`

Storing in-memory shuffle.

`spark.storage.safetyFraction`

`spark.executor.memory`

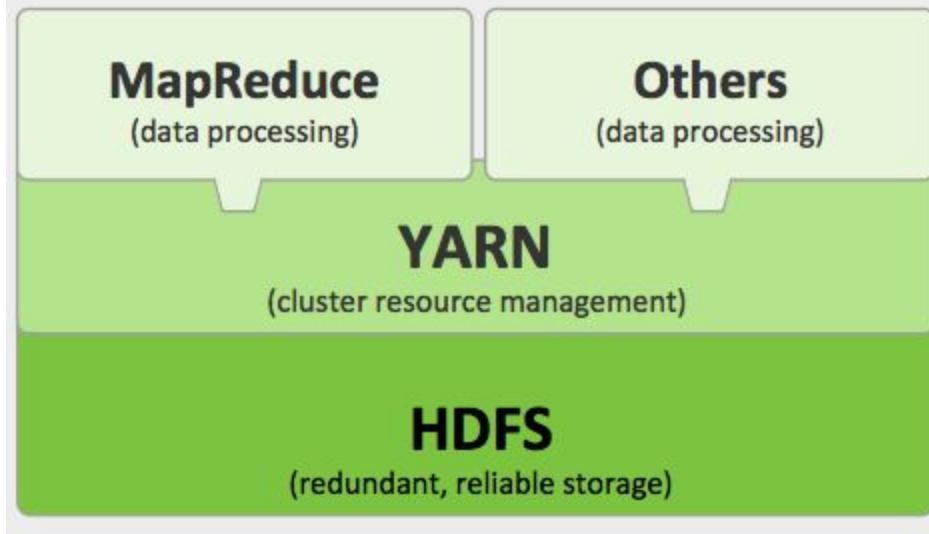


Spark and Hadoop Difference

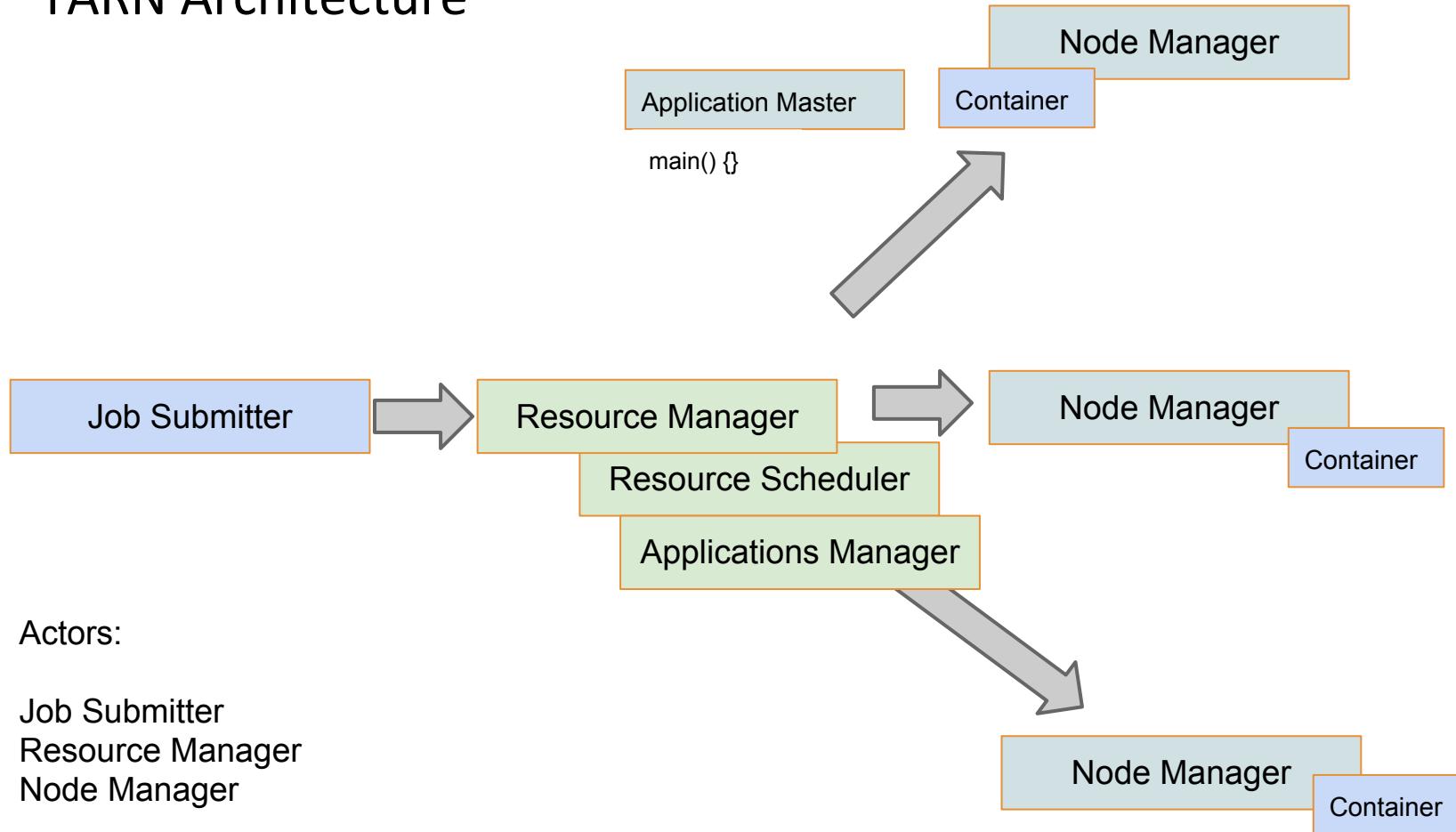
Hadoop - MR	Spark
The dataflow is fixed and predefined. We just fill in the code for mapper() and reducer().	In Spark, the dataflow can be complicated and coding is easy since the plumbing of the code is hidden from the programmer.
No plumbing of code.	Plumbing of the code. So programmer can concentrate on the business logic.



HADOOP 2.0



YARN Architecture



YARN Architecture

- [1] Client submits an application to the Resource Manager
- [2] Resource manager assigns a container by contacting the Node manager
- [3] The node manager launches the container
- [4] And at last the node manager executes the Application Master

YARN Architecture

```
localhost:hadoop tester$ cat mapred-site.xml
<?xml version="1.0"?>
<!DOCTYPE configuration SYSTEM "http://www.apache.org/xml/ns/policy.dtd">
<!--
    Licensed under the Apache License, Version 2.0 (the "License");
    you may not use this file except in compliance with the License.
    You may obtain a copy of the License at

        http://www.apache.org/licenses/LICENSE-2.0

    Unless required by applicable law or agreed to in writing, software
    distributed under the License is distributed on an "AS IS" BASIS,
    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
    See the License for the specific language governing permissions and
    limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->
<configuration>
    <property>
        <name>mapreduce.framework.name</name>
        <value>yarn</value>
    </property>

    <property>
        <name>mapreduce.jobhistory.address</name>
        <value>localhost:10020</value>
        <description>Host and port for Job History Server (default 0.0.0.0:10020)</description>
    </property>
</configuration>
localhost:hadoop tester$ cat yarn-site.xml
<?xml version="1.0"?>
<!--
    Licensed under the Apache License, Version 2.0 (the "License");
    you may not use this file except in compliance with the License.
    You may obtain a copy of the License at

        http://www.apache.org/licenses/LICENSE-2.0

    Unless required by applicable law or agreed to in writing, software
    distributed under the License is distributed on an "AS IS" BASIS,
    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
    See the License for the specific language governing permissions and
    limitations under the License. See accompanying LICENSE file.
-->
<configuration>
    <property>
        <name>yarn.nodemanager.aux-services</name>
        <value>mapreduce_shuffle</value>
    </property>
</configuration>
```

Storage Levels

- | | |
|---------------------|--|
| DISK_ONLY | - Store the RDD only on disk |
| MEMORY_ONLY | - Default mode. The RDD is stored in memory. If the some of the RDD doesn't fit in memory, they are computed each time whenever they are needed. |
| MEMORY_ONLY_SER | - Serialize data on memory. |
| MEMORY_AND_DISK | - Stores the partition on disk if it does not fit in memory. Also called as spilling (data spills to disk). |
| MEMORY_AND_DISK_SER | - Similar to MEMORY_ONLY_SER but spills data to the disk if the data doesn't fit to the memory. |

Storage Levels

There are other storage levels (with a numeric 2) specified below. Those represent the same behavior as said above but stores the partitions in two nodes (giving the spark a replication factor of 2).

DISK_ONLY_2

MEMORY_ONLY_2

MEMORY_ONLY_SER_2

MEMORY_AND_DISK_2

MEMORY_AND_DISK_SER_2

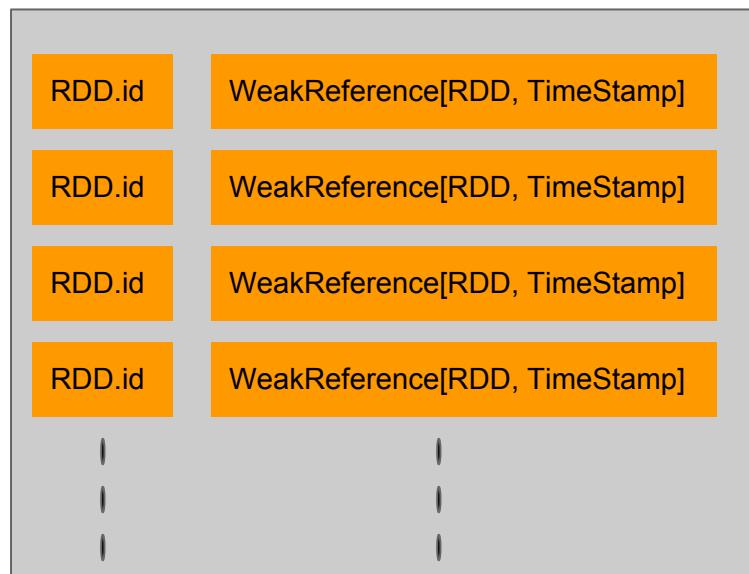
Persist - Unpersist - cache

```
JavaRDD<String> persistedRDD = rdd.persist(StorageLevel.DISK_ONLY());  
<<..... do complex stuff with persistedRDD.....>>  
persistedRDD.unpersist();
```

```
// Caching is nothing but the StorageLevel.MEMORY_ONLY()  
JavaRDD<String> cachedRDD = rdd.cache();
```

Persist - Unpersist - cache

When you persist an RDD, spark uses a hashtable to persist in data.



`TimeStampedWeakValueHashMap.scala`

`TimeStampedHashMap.scala`

`TimeStampedValue[V](
 value: V, timestamp: Long)`

`ConcurrentHashMap.scala`

Persist - Unpersist - cache

When you persist an RDD, spark uses a hashtable to persist in data.

TimeStampedWeakValueHashMap.scala

TimeStampedHashMap.scala

TimeStampedValue[V](value: V, timestamp: Long)

ConcurrentHashMap.scala

The TimeStampedWeakValueHashMap is the entity

MetadataCleaner.scala

Persist - Unpersist - cache

The TimeStampedWeakValueHashMap is the entity holding references of TimeStampedHashMap. These references are of WeakReference.

The TimeStampedHashMap inherently uses ConcurrentHashMap of TimeStampedValue case object.

The TimeStampedValue contains the data along with the timestamp value in long.

ConcurrentHashMap does not lock the entire map when reading and writing to it. Also it does not throw concurrent modification exception.

Shuffling

Shuffling is a process by which, the like key elements are brought together by the spark.

Certain API's in spark triggers shuffling. Operations that trigger shuffling are:

repartition(),

coalesce(),

groupByKey(),

reduceByKey(),

cogroup(),

join().

JDBC RDD

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);

JdbcRDD<Object[]> jdbcRDD =
    new JdbcRDD<>(javaSparkContext.sc(), dbConnection,
                    "select * from employees where emp_no >= ? and emp_no <= ?",
                    10001,
                    49999,
                    10,
                    new                                         MapResult(),
                    ClassManifestFactory$.MODULE$.fromClass(Object[].class));

jdbcRDD.foreach(null);
```

JDBC RDD

```
static class MapResult extends AbstractFunction1<ResultSet, Object[]> implements Serializable {  
  
    public Object[] apply(ResultSet row) {  
        return JdbcRDD.resultSetToObjectArray(row);  
    }  
}
```

```
static class DbConnection extends AbstractFunction0<Connection> implements Serializable {
```

```
    @Override  
    public Connection apply() {  
        return Connection();  
    }
```



Spark Streaming

Spark Streaming

Stream processing of spark allows in scalable, high-throughput, fault-tolerant stream processing of live data streams. By this data is ingested from streaming sources and processed data is saved in file systems.

StreamingContext is the entry point for Spark Streaming applications.
Equivalent to *SparkContext* in core Spark.

Spark Streaming



Spark Streaming

Spark uses DStreams (Discretized Streams) as the higher level of abstraction to read data from real time sources.

A streaming context is created in order to process DStreams.

```
JavaStreamingContext jsc = new JavaStreamingContext(sparkConfig, Durations.seconds(10));
```

Spark Streaming

```
// Start the execution of streams  
jsc.start();
```

```
// Waits on the streaming thread  
jsc.awaitTermination();
```

```
// Stop the streaming process  
jsc.stop();
```

Spark Streaming

Socket integration

Kafka integration

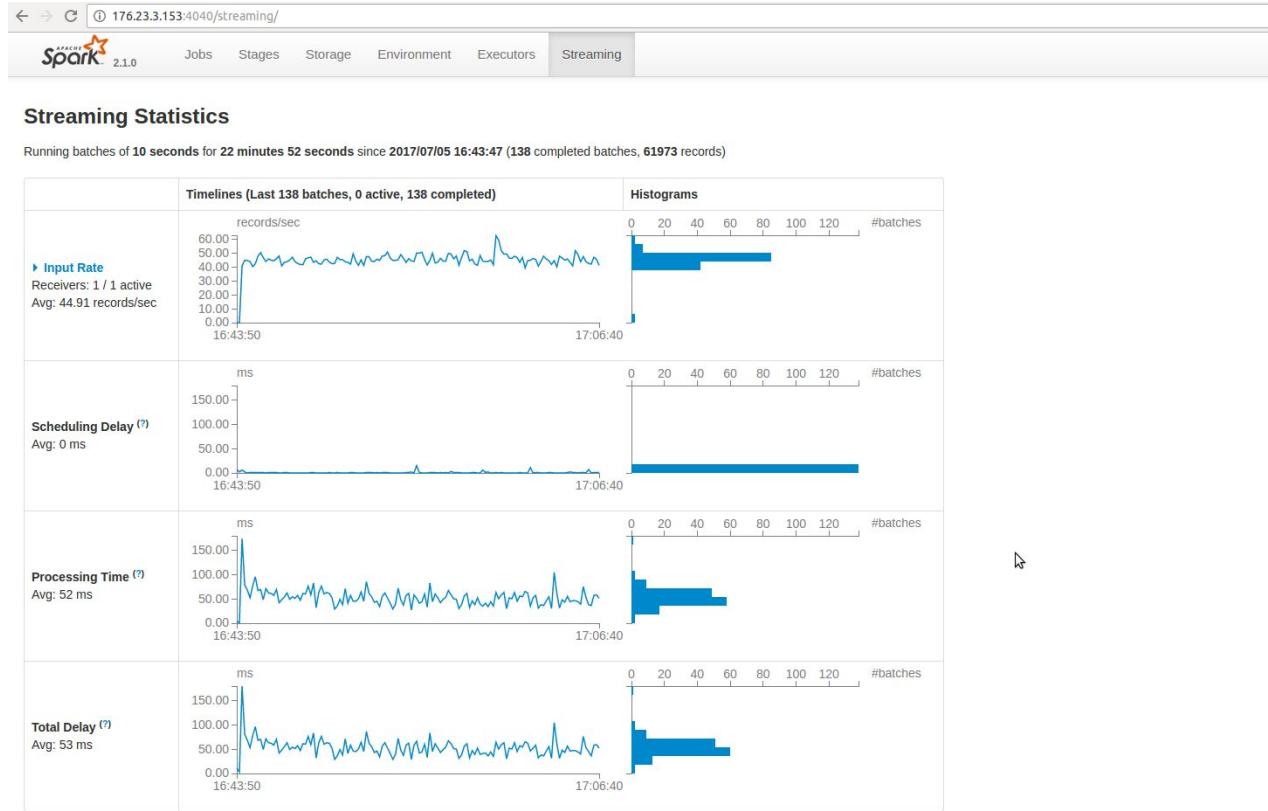
Flume integration

Twitter integration

Kinesis integration

Custom receiver integration

Spark Streaming UI



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Spark Streaming - Reading from socket

```
JavaStreamingContext jsc = new JavaStreamingContext(sparkConfig, Durations.seconds(10));
JavaReceiverInputDStream<String> streamOfLines = jsc.socketTextStream("localhost", 5555);

JavaDStream<String> dStream = streamOfLines.flatMap(z -> Arrays.asList(z.split(" ")));

JavaPairDStream<String, Integer> pairDStream = dStream.mapToPair(
    new PairFunction<String, String, Integer>() {

        @Override
        public Tuple2<String, Integer> call(String input) throws Exception {
            int lengthOfString = input.length();
            return new Tuple2<String, Integer>(input, new Integer(lengthOfString));
        }
    });
pairDStream.print();
jsc.start();
jsc.awaitTermination();
```

Spark Streaming - Reading from socket

```
val config = new SparkConf  
config.setMaster("local[4]")  
config.setAppName("StreamingSocket")  
  
val streamingContext = new StreamingContext(config, Duration(10))  
val dStream =  
    streamingContext.socketTextStream("localhost",  
        4444, StorageLevel.MEMORY_ONLY)  
  
dStream.print()  
  
streamingContext.start  
streamingContext.awaitTermination
```

Spark Streaming - Reading from socket

```
$ nc -lk <port_no>
```

```
$ nc -lk 5555
```

The above utility can send data from the command line.

Spark Streaming - Kafka

```
SparkConf sparkConfig = new SparkConf()  
    .setAppName("KafkaStreaming")  
    .setMaster("local[8]");  
  
JavaStreamingContext jsc = new JavaStreamingContext(sparkConfig, Durations.seconds(5));  
  
Map<String, Integer> params = new HashMap();  
params.put("Lohith_Topic", 1);  
  
JavaPairReceiverInputDStream<String, String> receive =  
    KafkaUtils.createStream(jsc, "localhost:2181", "GROUP-ID", params);  
  
receive.print();  
jsc.start();  
jsc.awaitTermination();
```

Spark Streaming - Kafka

```
val conf = new SparkConf()
conf.setAppName(HASHCONFIG.APP_STREAMING_NAME)
conf.setMaster(HASHCONFIG.MASTER_URL)
conf.set("es.index.auto.create", "true")

val sparkContext = new SparkContext(conf)
val streamingContext = new StreamingContext(sparkContext, Seconds(1))

val kafkaParams = Map[String, String]("metadata.broker.list" -> "localhost:9092")
val messages = KafkaUtils.createDirectStream[String, String](StringDecoder, StringDecoder)(streamingContext, kafkaParams, Set("HASH"))

messages.print

// val microbatches = mutable.Queue(messages);
// streamingContext.queueStream(microbatches).saveToEs("hash360index/fields")

/*
 * ("custom-index-{date}/customtype")
 * ("custom-index-{date:{YYYY.mm.dd}}/customtype")
 */
messages.foreachRDD((x,y) => EsSpark.saveToEs(x, "hash360index/fields"))

streamingContext.start()
streamingContext.awaitTermination()
chinnasamyad@gmail.com
```

```
object HASHCONFIG extends Enumeration {
  type HASHCONFIG = Value
  var APP_STREAMING_NAME = "Hash360StreamingJOB"
  var MASTER_URL = "local[*]"
  var KAFKA_BROKER = "localhost:9092"
}
```

The Kafka old API

Spark Streaming - Kafka

```
<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-streaming_2.11</artifactId>
  <version>1.6.0</version>
</dependency>

<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-streaming-kafka_2.11</artifactId>
  <version>1.6.0</version>
</dependency>

<dependency>
  <groupId>org.elasticsearch</groupId>
  <artifactId>elasticsearch-spark-13_2.11</artifactId>
  <version>5.0.0</version>
</dependency>
```

The Kafka old API

Spark Streaming - Kafka

```
val sparkConf = new SparkConf()
```

```
sparkConf.setAppName("StreamingJOB").setMaster("local[*]")
```

```
val sparkContext1 = new SparkContext(sparkConf)
```

```
val streamingContext = new StreamingContext(sparkContext1, Seconds(2))
```

```
import org.apache.kafka.clients.consumer.ConsumerRecord
```

```
import org.apache.kafka.common.serialization.StringDeserializer
```

```
import org.apache.spark.streaming.kafka010._
```

```
import org.apache.spark.streaming.kafka010.LocationStrategies.PreferConsistent
```

```
import org.apache.spark.streaming.kafka010.ConsumerStrategies.Subscribe
```

The Kafka new API

Spark Streaming - Kafka

```
val kafkaParams = Map[String, Object](  
    "bootstrap.servers" -> "localhost:9092",  
    "key.deserializer" -> classOf[StringDeserializer],  
    "value.deserializer" -> classOf[StringDeserializer],  
    "group.id" -> "GROUP-ID",  
    "auto.offset.reset" -> "latest",  
    "enable.auto.commit" -> (false: java.lang.Boolean)  
)
```

```
val topics = Array("DMAC")  
val stream = KafkaUtils.createDirectStream[String, String](  
    streamingContext,  
    PreferConsistent,  
    Subscribe[String, String](topics, kafkaParams)  
)
```

```
stream.map(record => (record.key, record.value)).print()
```

The Kafka new API

```
streamingContext.start()
```

```
streamingContext.awaitTermination()
```

Spark Streaming - Kafka

```
Dharshekths-MacBook-Pro:bin dharshekthvel$ ./kafka-console-producer.sh --broker-list localhost:9092 --topic DMAC
```

Use the kafka console producer command to publish to the topic.

The Kafka new API

Spark Streaming - Twitter

```
object SparkTwitterConnector extends App {  
  
    val conf = new SparkConf()  
    conf.setAppName(HASHCONFIG.APP_STREAMING_NAME)  
    conf.setMaster(HASHCONFIG.MASTER_URL)  
    conf.set("es.index.auto.create", "true")  
    conf.set("es.nodes", "localhost:9200")  
  
    val sparkContext = new SparkContext(conf)  
    sparkContext.setLogLevel("WARN")  
  
    val streamingContext = new StreamingContext(sparkContext, Seconds(180))
```

```
System.setProperty("twitter4j.oauth.consumerKey", "H7gCcVkw7HI8C4hbgEo62h6zF")  
System.setProperty("twitter4j.oauth.consumerSecret",  
"yGgJ8IT5FKoNcrMWCE31tmQqtkzPiSnhIX9XuXIFP4P54XVdxg")  
System.setProperty("twitter4j.oauth.accessToken",  
"837928192170209280-v0p7XGPdehsV0VSTouN6YisQReaEQGt")  
System.setProperty("twitter4j.oauth.accessTokenSecret",  
"6HnqRgWUyQWPSUfKKpthSP7jXUBFfU7hVop6vlfJxUQpL")
```

```
val stream = TwitterUtils.createStream(streamingContext, None)  
//val tags = stream.flatMap { status => status.getHashtagEntities.map(_.getText) }  
  
chinni: val tweets = stream.filter {t =>  
    val tags = t.getText.split(" ").map(_.toLowerCase)
```

Spark Streaming - Twitter

```
<dependency>
  <groupId>org.elasticsearch</groupId>
  <artifactId>elasticsearch-spark-13_2.11</artifactId>
  <version>5.0.0</version>
</dependency>

<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-streaming-twitter_2.10</artifactId>
  <version>1.6.0</version>
</dependency>

<dependency>
  <groupId>org.apache.spark</groupId>
  <artifactId>spark-streaming_2.11</artifactId>
  <version>1.6.0</version>
</dependency>
```

Spark Streaming - Twitter



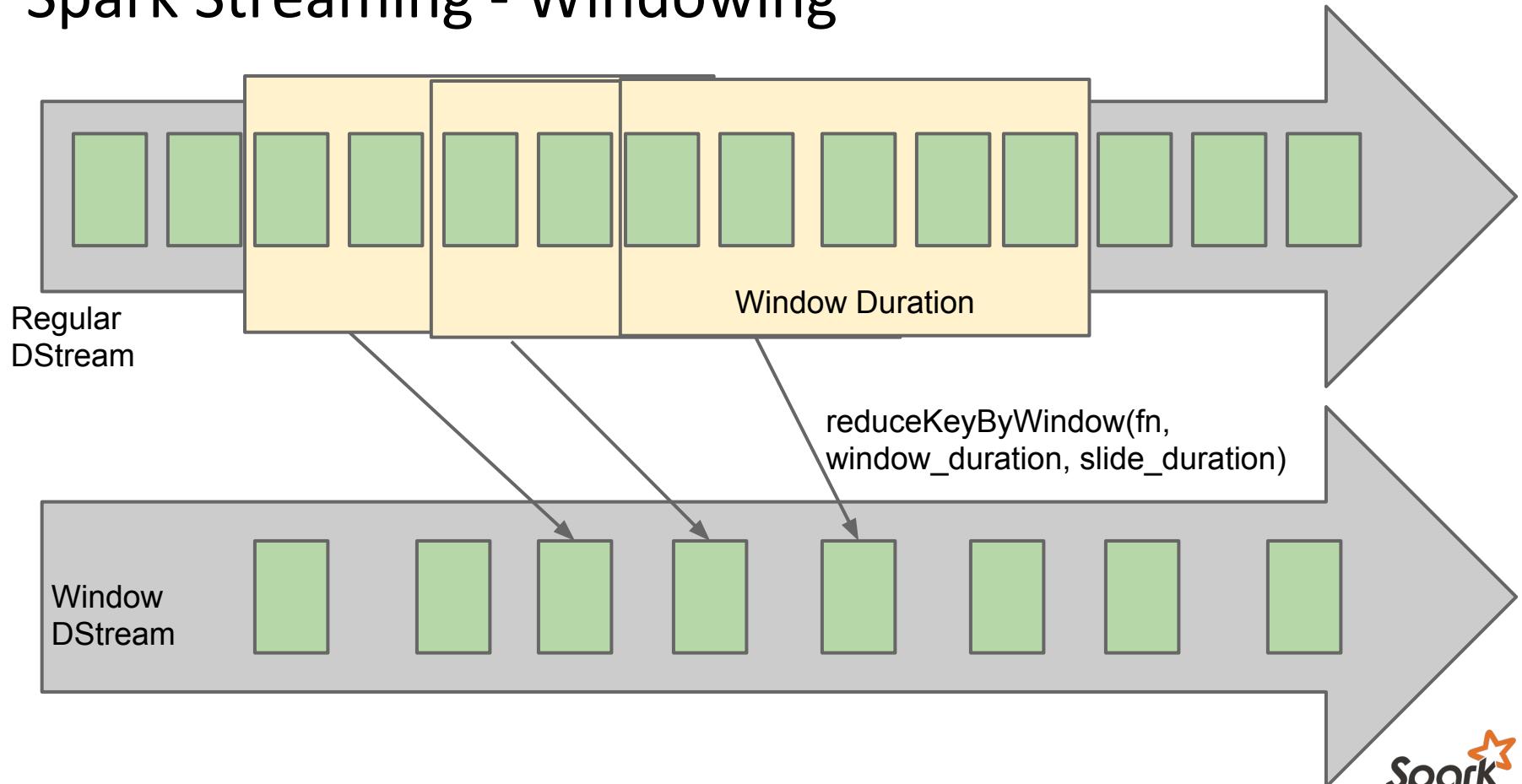
Spark 2.0 - Twitter, Akka, MQTT, ZeroMQ has been moved to Apache Bahir, so that development can be fast in the community.

```
<dependency>
  <groupId>org.apache.bahir</groupId>
  <artifactId>spark-streaming-twitter_2.11</artifactId>
  <version>2.1.0</version>
</dependency>
```

Spark Streaming - Twitter



Spark Streaming - Windowing



Spark Streaming - Windowing

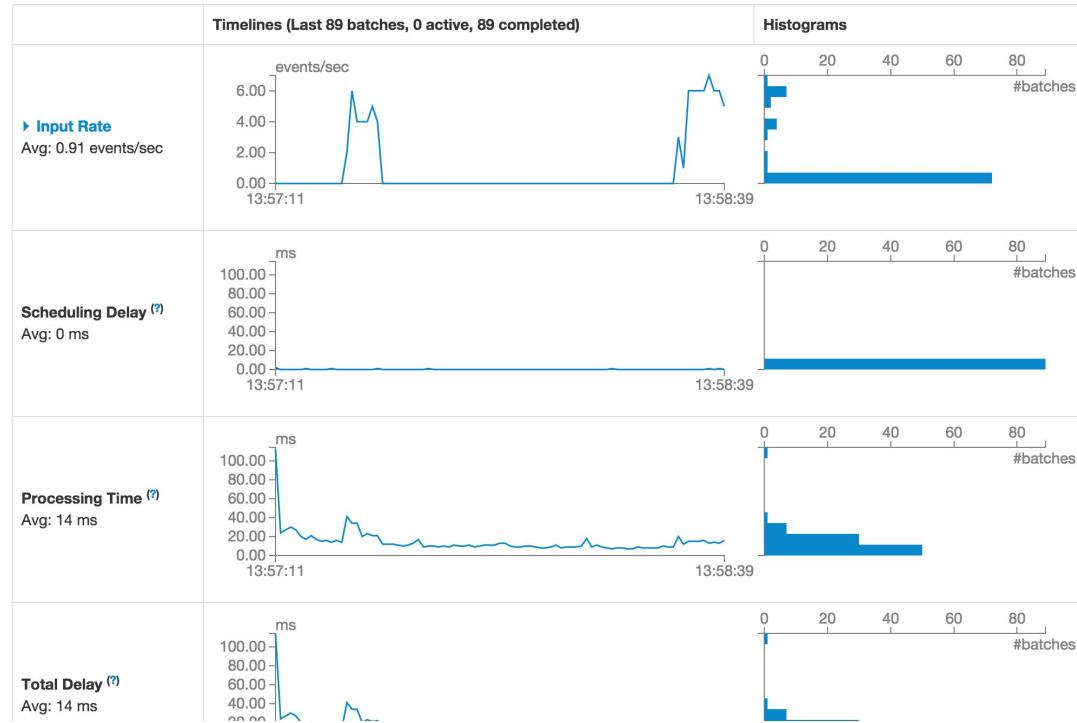
```
JavaStreamingContext jsc = new JavaStreamingContext(sparkConfig, Durations.seconds(5));  
  
JavaReceiverInputDStream<String> streamOfLines = jsc.socketTextStream("localhost", 5555);  
  
streamOfLines.reduceByWindow(new Function2<String, String, String>() {  
  
    @Override  
    public String call(String arg0, String arg1) throws Exception {  
        return arg1.concat(arg0);  
    }  
}, Durations.seconds(15), Durations.seconds(5)).foreach(new Function<JavaRDD<String>, Void>() {  
  
    @Override  
    public Void call(JavaRDD<String> arg0) throws Exception {  
        arg0.foreach(param -> System.out.println("\n\n\n\n\n\n\n\nOUTPUT - " + param));  
        return null;  
    }  
});  
jsc.start();  
jsc.awaitTermination();
```

Spark Streaming - UI



Streaming Statistics

Running batches of 1 second for 1 minute 30 seconds since 2015/09/20 13:57:09 (89 completed batches, 81 records)



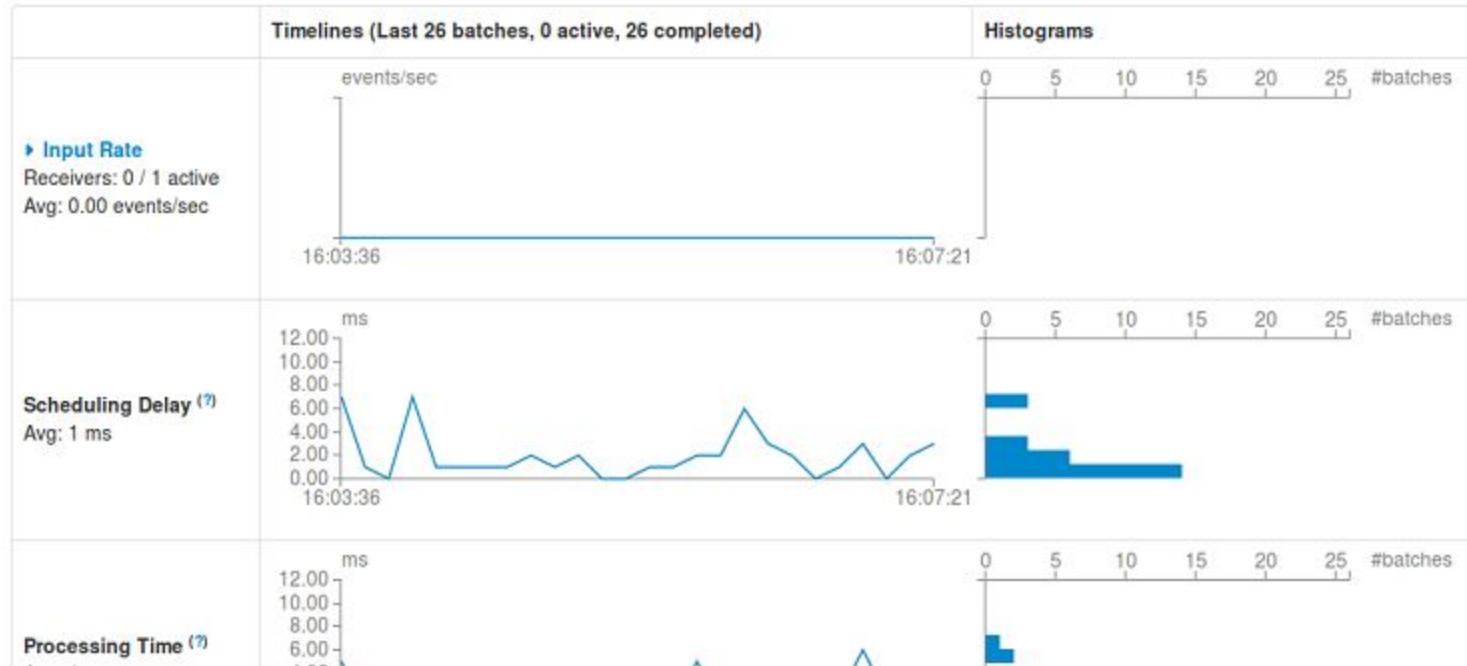
Spark Streaming - UI

localhost:4040/streaming/ Search

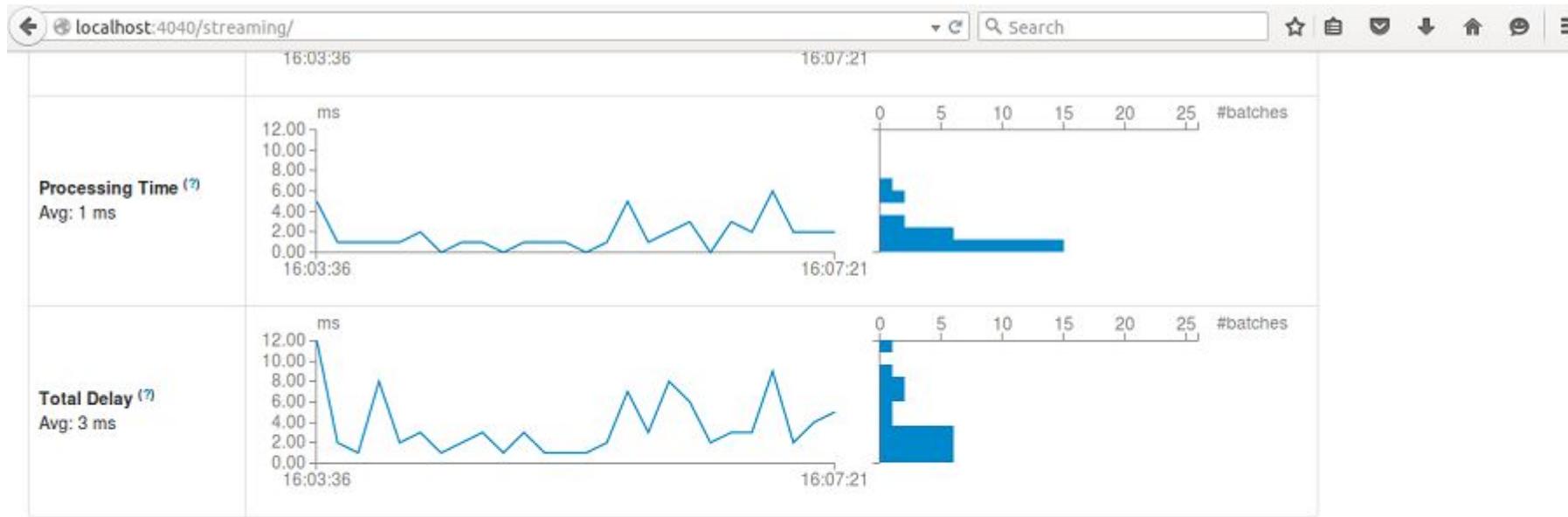
Spark 1.6.0 Jobs Stages Storage Environment Executors Streaming ReadingFile application UI

Streaming Statistics

Running batches of 9 seconds for 3 minutes 55 seconds since 2016/02/02 16:03:28 (26 completed batches, 0 records)



Spark Streaming - UI



Active Batches (0)

Batch Time	Input Size	Scheduling Delay (ms)	Processing Time (ms)	Output Ops: Succeeded/Total	Status
------------	------------	-----------------------	----------------------	-----------------------------	--------

Completed Batches (last 26 out of 26)

Batch Time	Input Size	Scheduling Delay (ms)	Processing Time (ms)	Total Delay (ms)	Output Ops: Succeeded/Total
2016/02/02 16:07:21	0 events	3 ms	2 ms	5 ms	1/1
2016/02/02 16:07:12	0 events	2 ms	2 ms	4 ms	1/1
2016/02/02 16:07:03	0 events	0 ms	2 ms	2 ms	1/1

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Spark Streaming - Connecting to other sources

```
JavaStreamingContext jsc = new JavaStreamingContext(config, Durations.seconds(10));
JavaDStream<Status> tweets = TwitterUtils.createStream(jsc);

JavaDStream<String> statuses = tweets.map(
    new Function<Status, String>() {
        public String call(Status status) {
            String tweets = status.getText();
            if (tweets.equals("LOHITHAAA"))
                return status.getText();
            return "";
        }
    });
statuses.print();
```

FlumeUtils.createStream()

KinesisUtils.createStream

Spark Custom Receiver

```
public class MyOwnCustomReceiver extends Receiver<TitanicBean> {

    public MyOwnCustomReceiver(StorageLevel storageLevel) {
        super(StorageLevel.MEMORY_ONLY());
    }

    @Override
    public void onStart() {
        new Thread() {
            @Override public void run() {
                <<listen_to_a_socket>>
            }
        }.start();
    }

    @Override
    public void onStop() {
    }
}
```

Spark Custom Receiver

```
SparkConf sparkConfig = new SparkConf()
```

```
    .setAppName("SparkStreaming")  
    .setMaster("local[5]");
```

```
JavaStreamingContext jsc = new JavaStreamingContext(sparkConfig, Durations.seconds(10));
```

```
JavaReceiverInputDStream<String> streamOfLines
```

```
= jsc.receiverStream(new MyOwnCustomReceiver(StorageLevel.MEMORY_ONLY()));
```

Back pressure

In spark streaming, there can be at times where there are tons of data that are popping in.

You can see that there is a sudden spike of data when we are listening on a twitter or on a particular socket.

In order to handle to such a huge volume of data ingestion the back pressure algorithm had been introduced in spark.

Spark back pressure can be enabled through the config setting
`conf.set("spark.streaming.backpressure.enabled","true")`.

Custom Partitioning - Spark

By default, spark uses HashPartitioning for manipulating data in memory.

Let's write a custom partitioner for partitioning the data in memory.

For to do a custom partitioning, you need to have a PairRDD data structure.

Custom Partitioning - Spark

The below Partitioner partitions the data based on the year, which is a Int field. The usage is shown on the next slide.

```
class YearPartitioner extends Partitioner {  
  
    override def numPartitions: Int = {  
        15  
    }  
  
    override def getPartition(key: Any): Int = {  
        val k = key.asInstanceOf[Int]  
        if (k > 2000)  
            10  
        else if (k > 1900 && k < 2000)  
            11  
        else  
            12  
    }  
}
```

YearPartitioner.scala

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Custom Partitioning - Spark

```
-- Our usual stuffs. Create the data ---  
val sparkContext = new SparkContext(sparkConfig)  
val list = List(1923, 1800, 2012, 1834, 1987, 2014);  
val listRDD = sparkContext.parallelize(list)  
  
-- Create the Pair RDD for partitioning --  
val pairRDD = listRDD.map(x => (x,0))  
  
val partitionedData = pairRDD.partitionBy(new YearPartitioner)  
  
// partitionedData.mapPartitions(dataIterator =>  
//     dataIterator.map(dataInfo => println(dataInfo)))  
//     .collect()  
  
val mapPartitionIndexRDD = partitionedData.mapPartitionsWithIndex((partitionIndex, dataIterator) =>  
    dataIterator.map(dataInfo => "Partition is - " + partitionIndex + " - Data = " + dataInfo))  
  
mapPartitionIndexRDD.saveAsTextFile("/home/dharshekthvel/dele199")  
  
print("Partitioner " + partitionedData.partitioner)
```

YearPartitioner.scala

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Spark SQL

SQL Query Engine for Spark

Spark SQL

SparkSQL is the query engine querying structured data sitting on top of an abstraction called DataFrames.

```
SparkConf sparkConfig = new SparkConf()  
    .setAppName("DataFrames")  
    .setMaster("local[5]");
```

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);
```

```
SQLContext sc = new SQLContext(javaSparkContext);  
DataFrame df = sc.read().json("file:///Users/tester/ac/ycy.json");  
df.printSchema();
```

Spark SQL

SparkSQL is the query engine querying structured data sitting on top of an abstraction called DataFrames.

```
val sparkSession = SparkSession.builder()  
    .appName("SQLJob")  
    .master("local[*]")  
    .getOrCreate()
```

```
val salesCSV = sparkSession.sqlContext.read.option("header","true")  
    .csv("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/sales.csv")
```

Spark 2.0

Spark SQL

DataFrame is the abstraction for SparkSQL. Internally it is composed of data organized as named columns.

In the spark source, refer DataFrame.scala for more insight.

Spark SQL

A Dataframe is a distributed collection of data organized into columns.
Nothing but a table of a relational database.

With Spark 2.0, DataFrame is a synonym of Dataset[Row].
The Dataset is more recommended.

Dataset store data in a optimized binary format, in heap memory, to avoid the cost of deserialization and garbage collection. Spark creates its own optimized byte-code for accessing the data directly.

Spark SQL

Dataset

A dataset is a strongly typed immutable collection of objects that are mapped to a relational schema.

Dataset are encoded objects with the tungsten optimizer of spark which helps in serialization and memory efficiency.

Dataframes are nothing but datasets organized as named columns.

Spark SQL

Spark 2.0

SparkSQL from Spark 2.0 supports majority of the queries.
It can run 99 queries of the TPC-DS specification.

In Spark 2.0, there are significant changes, there is no backward compatibility.
You need to migrate the code from Spark 1.x to Spark 2.x

Subquery support has been added in Spark 2.0

Transaction Processing Performance Council (TPC) sets a benchmark for SQL engines.
Visit [www.tpc.org](http://www(tpc.org)

Spark SQL

Creation of dataset. Dataset are created by two ways:

```
[1] val dataset = sparkSession.createDataset(List("IN", "US", "HK"))
```

```
[2] val csvDataSetText =
sparkSession.read.text("hdfs://localhost:9000/covtype.info").as[String]
csvDataSetText.foreach(x => println(x))
```

Spark SQL

```
SparkConf sparkConfig = new SparkConf()  
    .setAppName("ReadLogFile")  
    .setMaster("local[5]");
```

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);
```

```
SQLContext sqlContext = new SQLContext(javaSparkContext);  
DataFrame df = sqlContext.read().json("file:///Users/koteshwar/world_bank.json");  
  
df.show();
```

Spark SQL

approvalfy	board_approval_month	boardapprovaldate	borrower	closingdate	country_namecode	countrycode	countryname	countryshortname	doctylenav
1999	November	2013-11-12T00:00:00Z	FEDERAL DEMOCRATI...	2018-07-07T00:00:00Z	Federal Democrati...	ETI	Federal Democrati...	Ethiopia	Project Informati...
2015	November	2013-11-04T00:00:00Z	GOVERNMENT OF TUN...	null	Republic of Tunis...	TNI	Republic of Tunisia	Tunisia	Project Informati...
2014	November	2013-11-01T00:00:00Z	MINISTRY OF FINAN...	null	Tuvalu\$!TVI	TVI	Tuvalu	Tuvalu	Resettlement Plan...
2014	October	2013-10-31T00:00:00Z	MIN. OF PLANNING ...	null	Republic of Yemen...	RYI	Republic of Yemen Yemen, Republic of	Yemen	Procurement Plan...
2014	October	2013-10-31T00:00:00Z	MINISTRY OF FINANCE	2019-04-30T00:00:00Z	Kingdom of Lesotho...	LSI	Kingdom of Lesotho	Lesotho	Project Informati...
2014	October	2013-10-31T00:00:00Z	REPUBLIC OF KENYA	null	Republic of Kenya...	KEI	Republic of Kenya	Kenya	Integrated Safegu...
2014	October	2013-10-29T00:00:00Z	GOVERNMENT OF INDIA	2019-06-30T00:00:00Z	Republic of India...	INI	Republic of India	India	Project Appraisal...
2014	October	2013-10-29T00:00:00Z	PEOPLE'S REPUBLIC...	null	People's Republic...	CNI	People's Republic...	China	Project Appraisal...
2014	October	2013-10-29T00:00:00Z	THE GOVERNMENT OF...	2018-12-31T00:00:00Z	Republic of India...	INI	Republic of India	India	Project Appraisal...
2014	October	2013-10-29T00:00:00Z	THE KINGDOM OF MO...	2014-12-31T00:00:00Z	Kingdom of Morocco	MAI	Kingdom of Morocco	Morocco	Program Document...
2014	October	2013-10-25T00:00:00Z	GOVERNMENT OF SOU...	null	Republic of South...	SSI	Republic of South...	South	Sudan Project Paper, Pro...
2014	October	2013-10-25T00:00:00Z	null	2017-12-31T00:00:00Z	Republic of India...	INI	Republic of India	India	Project Appraisal...
2014	October	2013-10-24T00:00:00Z	GOVERNMENT OF GHANA	2019-06-30T00:00:00Z	Republic of Ghana...	GHI	Republic of Ghana	Ghana	Project Appraisal...
2014	October	2013-10-22T00:00:00Z	GOVERNMENT OF TIM...	null	Democratic Republ...	TPD	Democratic Republ...	Timor-Leste	Integrated Safegu...
2014	October	2013-10-22T00:00:00Z	GOVERNMENT OF JORDANI	null	Hashemite Kingdom...	JOI	Hashemite Kingdom...	Jordan	null
2014	October	2013-10-17T00:00:00Z	MINISTRY OF FINANCE	2019-04-30T00:00:00Z	Samoa\$!WSI	WSI	Samoan	Samoa	Environmental Ass...
2014	October	2013-10-17T00:00:00Z	MINISTRY OF FINANCE	2015-12-31T00:00:00Z	Samoa\$!WSI	WSI	Samoan	Samoa	Project Appraisal...
2014	October	2013-10-16T00:00:00Z	MINISTRY OF FINAN...	null	Republic of Madag...	MGI	Republic of Madag...	Madagascar	Integrated Safegu...
2014	October	2013-10-16T00:00:00Z	ROYAL GOVERNMENT ...	null	Kingdom of Cambod...	KHI	Kingdom of Cambod...	Cambodia	Project Informati...
2014	October	2013-10-10T00:00:00Z	MINISTRY OF FINANCE	null	Kingdom of Morocco...	MAI	Kingdom of Morocco	Morocco	Project Informati...

Spark SQL - select variants

```
df.select("borrower").show();
```

```
df.select("borrower", "country_namecode").show();
```

```
df.select(df.col("borrower"), df.col("country_namecode")).show();
```

Spark SQL - select variants

```
df.select(df.col("borrower"), df.col("grantamt").plus(1)).show();
```

```
df.select(df.col("borrower"), df.col("grantamt").gt(15000000)).show();
```

Spark SQL - operations

```
df.groupBy("countryshortname").count().show();
```

DataFrames - Writing the output

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);

    SQLContext sqlContext = new SQLContext(javaSparkContext);
    DataFrame df =
sqlContext.read().json("file:///Users/apple/world_bank.json");

    df.select("borrower",
"country_namecode").write().json("file:///Users/apple/out");
```

DataFrames - Writing the output

```
Apples-MacBook-Pro:out apple$ ls
_SUCCESS          part-00000      part-00001
Apples-MacBook-Pro:out apple$ 
Apples-MacBook-Pro:out apple$ 
Apples-MacBook-Pro:out apple$ 
Apples-MacBook-Pro:out apple$ cat part-00001
{"borrower":"GOVERNMENT OF COMOROS","country_namecode":"Union of the Comoros(!$!KM"}
 {"borrower":"GOVERNMENT OF SRI LANKA","country_namecode":"Democratic Socialist Republic of Sri Lan(!$!LK"}
 {"borrower":"HALK BANK; VAKIF BANK; ZIRAAT BANK","country_namecode":"Republic of Turkey(!$!TR"}
 {"borrower":"GOVERNMENT OF MOROCCO","country_namecode":"Kingdom of Morocco(!$!MA"}
 {"borrower":"GOVERNMENT OF MAURITIUS","country_namecode":"Republic of Mauritius(!$!MU"}
 {"borrower":"REPUBLIC OF ARMENIA","country_namecode":"Republic of Armenia(!$!AM"}
 {"borrower":"HALKBANK,VAKIFBANK,ZIRAATBANK","country_namecode":"Republic of Turkey(!$!TR"}
 {"borrower":"GOVERNMENT OF MAURITIUS","country_namecode":"Republic of Mauritius(!$!MU"}
 {"borrower":"UNITED REPUBLIC OF TANZANIA","country_namecode":"United Republic of Tanzania(!$!TZ"}
```

Spark SQL - Writing a Select Query on View

```
val jsonDataFrame = sparkSession.read.json("examples/src/main/resources/people.json")  
  
val csvDataFrame =  
sparkSession.read.csv("/Users/dharshekthvel/ac/training/sparktraining/data/undata1.csv")  
  
csvDataFrame.createTempView("DATATABLE")  
csvDataFrame.createOrReplaceTempView("MYOWNTABLE")  
csvDataFrame.createGlobalTempView("STRUCTUREDTABLE")  
  
sparkSession.sql("SELECT _c0,_c1 FROM DATATABLE").show(100)
```

Spark SQL - Select Query

Temp views in Spark are session scoped and terminates when the session terminates.

View that has to be shared among all sessions are created under createGlobalTempView

Global tables are accessed with global_temp table.

```
csvDataFrame.createGlobalTempView("STRUCTURETABLE")
```

```
sparkSession.sql("SELECT _c0,_c1 FROM global_temp.STRUCTURETABLE").show(100)
```

Spark SQL - Select Query

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);  
  
SQLContext sqlContext = new SQLContext(javaSparkContext);  
  
DataFrame df = sqlContext.read().json("file:///Users/apple/world_bank.json");  
df.registerTempTable("WORLD_BANK");  
  
DataFrame borrower_country = sqlContext.sql("select borrower, country_namecode from WORLD_BANK");  
  
borrower_country.show();
```

The registerTempTable is deprecated from 2.0, use createTempView

Spark SQL - Writing a UDF

```
/**  
 * borrowerConverter is the User Defined Function (UDF)  
 */  
UDF1 borrowerConverter = new UDF1<String, String>() {  
  
    @Override  
    public String call(String input) throws Exception {  
  
        if (input == null)  
            return "_EMPTY_";  
        else if (input.equals("MINISTRY OF FINANCE"))  
            return "FINANCE";  
        else  
            return input;  
    }  
};
```

Spark SQL - Writing a UDF

```
JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);

SQLContext sqlContext = new SQLContext(javaSparkContext);
DataFrame df = sqlContext.read().json("file:///C:/ac/spark/code/sparktraining/data/world_bank.json");
df.registerTempTable("WORLD_BANK");

sqlContext.udf().register("borrowerConverter", borrowerConverter, DataTypes.StringType);

DataFrame borrowerCountry = sqlContext.sql("select borrowerConverter(borrower), country_namecode
                                             from WORLD_BANK");

borrowerCountry.show();

javaSparkContext.close();
```

Spark SQL - JDBC

```
val sparkContext = new SparkContext(config)

val sqlContext = new SQLContext(sparkContext)

val df = sqlContext.read.format("jdbc").options(
    Map("url" -> "jdbc:mysql://127.0.0.1:3306/slz_core",
        "user" -> "slz02",
        "password" -> "slz02@123",
        "dbtable" -> "regions"))
    .load()

df.select("name").show()

sparkContext.stop()
```

Don't use JDBCRDD. JDBCRDD is not recommended.

Spark SQL - Saving Data...

```
val requiredDataFrame = sparkSession.sql("SELECT _c0,_c1 FROM global_temp.STRUCTUREDTABLE")  
  
requiredDataFrame.write.csv("/Users/dharshekthvel/ac/out.csv")  
  
requiredDataFrame.write.parquet("/Users/dharshekthvel/ac/out.parquet")  
  
requiredDataFrame.write.json("/Users/dharshekthvel/ac/out.json")
```

Any DataFrame can be saved as a csv, parquet, or json. The data gets saved in a directory as a partition.

```
/Users/dharshekthvel/ac/out.csv  
[Dharshekths-MacBook-Pro:out.csv dharshekthvel$ ls  
_SUCCESS  
part-00000-93c2d6ed-1512-4609-a20c-b3dad78719f0.csv  
Dharshekths-MacBook-Pro:out.csv dharshekthvel$ ]
```

Spark SQL - Know your data

```
val sparkSession = SparkSession.builder().appName("SQLJob").master("local[*]").getOrCreate()
```

```
import sparkSession.implicits._
```

```
val electionCSV = sparkSession.sqlContext.read.option("header", "true")  
.csv("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/electiondata.csv")
```

```
electionCSV.describe("CQ").show()
```

```
electionCSV.describe("REP_NAME").show()
```

summary	CQ
count	534702
mean	309.86206896551727
stddev	182.16032657046628
min	10
max	99

summary	REP_NAME
count	534702
mean	null
stddev	null
min	ABERCROM
max	YOUNG

Statistical Exploration

Spark SQL - Change your schema

```
val toDouble = udf[Double, String](_.toDouble)
```

Change your schema-datatype using the UDF function.

```
salesCSV.show(100)  
salesCSV.printSchema()
```

```
val salesDF = salesCSV.toDF()
```

```
val salesModifiedSchema = salesCSV.withColumn("Revenue", toDouble(salesDF.col("Revenue")))
```

```
salesModifiedSchema.printSchema()
```

One of the common operations done. In the above code, the column Revenue is converted from String to Double. This can be viewed by using the printSchema() before and after the schema modification.

Dataset API

Dataset API

Introduced in Spark 1.6, Dataset is a distributed collection of data.

Dataset API's are infact RDD's which use specific encoders to serialize the object rather than using java serialization or kryo serialization.

Optimized API's in computation.

A Dataframe is a Dataset organized into named columns.

Always use this. All futuristic API's of Spark will be using dataset's heavily.

Dataset API

A Dataset API executes much faster than a native RDD.

Datasets uses low memory footprint.

Datasets uses encoders which are highly optimized and uses runtime code generation to build custom bytecode for serialization/deserialization.

Dataset API

```
List<String> data = Arrays.asList("Spark", "is", "doing", "awesome");

SparkConf sparkConfig = new SparkConf()
    .setAppName("DatasetAPI")
    .setMaster("local[8]");

JavaSparkContext javaSparkContext = new JavaSparkContext(sparkConfig);

SQLContext sqlContext = new SQLContext(javaSparkContext);

Dataset<String> dataset = sqlContext.createDataset(data, Encoders.STRING());

dataset.foreach(eachElement -> System.out.println(eachElement));
```

Dataset API

```
val config = new SparkConf()

config.setMaster("local")
config.setAppName("DatasetElucidation")

val sc = new SparkContext(config)

val sqlContext = new SQLContext(sc)

val list = List("A", "Simple", "Spark", "List")

import sqlContext.implicits._

val lines = sqlContext.createDataset(list).as[String]

lines.foreach(x => println(x))
```

Dataset API

```
val sparkSession = SparkSession.builder()
    .appName("SparkJOB").master("local[*]")
    .getOrCreate()

import sparkSession.implicits._

val dataset = sparkSession.createDataset(List(
    "INVESTMENT_BANK_TIMELINE_01",
    "INVESTMENT_BANK_TIMELINE_02",
    "INVESTMENT_BANK_TIMELINE_003"))

val lengthDataset = dataset.map(each => each.length)

lengthDataset.foreach(x => println(x))
```

Dataset API

Spark 1.X

Dataframe is structured abstraction over the RDD.

Spark 2.X

From Spark 2.x, the dataframe is an alias of Dataset[Row].

Dataset supports Structured Querying using DSL and SQL. Also it supports functional API's.

Dataset API - Advantages

Gives high performance throughput.

Catalog API - Introduced in Spark 2.0

Dataset and Dataframe supports structured data analysis in Spark.

The Catalog API is used for accessing metadata on the SQL Context of Spark.

Catalog is available in SparkSession

Catalog API - Introduced in Spark 2.0

```
sparkSession.catalog.refreshTable("")
```

```
sparkSession.catalog.cacheTable("")
```

```
sparkSession.catalog.clearCache()
```

```
sparkSession.catalog.dropTempView("")
```

```
sparkSession.catalog.dropGlobalTempView("")
```

```
sparkSession.catalog.createExternalTable("", "")
```

Apache Parquet

Parquet

Parquet is the file format for storing data in a columnar format.

Spark SQL heavily embraces Parquet format for operating on SQL.

Use Parquet file format when and wherever possible with SQL.
Because parquet performs much better than CSV or JSON.

The screenshot shows the official Apache Parquet website at <https://parquet.apache.org>. The header includes the Apache logo, the Parquet logo (a blue diamond shape with white lines), and navigation links for Documentation, Download, Presentations, Adopters, and Get Involved. Below the header, a breadcrumb trail shows 'Apache Software Foundation' and 'Apache Parquet'. A main text box states: 'Apache Parquet is a [columnar storage](#) format available to any project in the Hadoop ecosystem, regardless of the choice of data processing framework, data model or programming language.'

Parquet

Parquet is a columnar storage of data and so aggregation queries are faster.

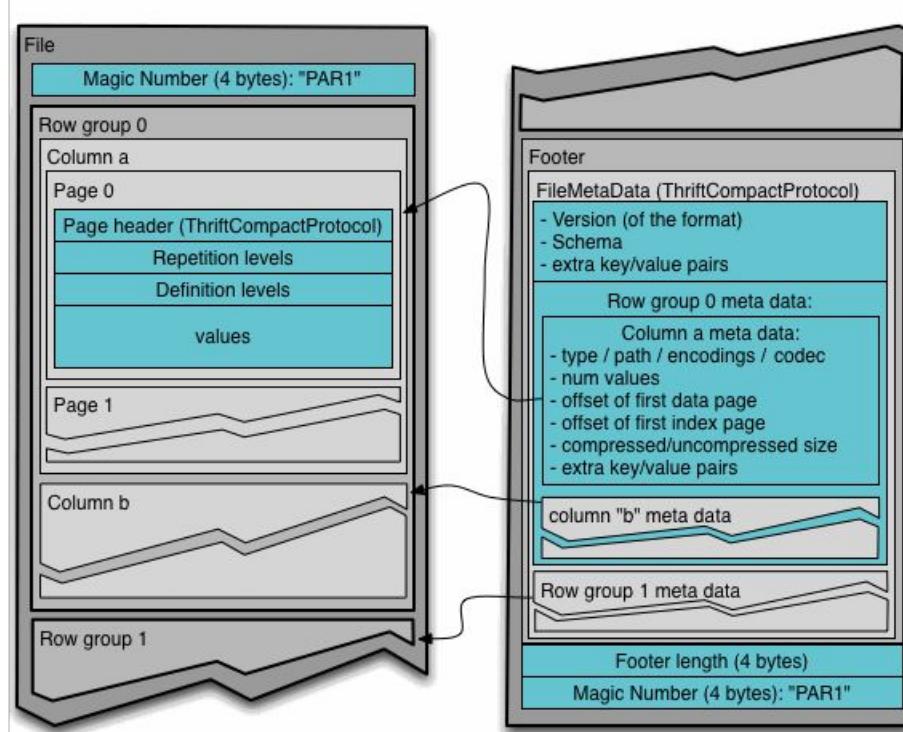
The required columns are read from the disk.

Data has the schema.

Parquet supports compression in data storage.

Parquet default compression format is Snappy.

Parquet



Source : <https://parquet.apache.org/documentation/latest/>

Parquet

Parquet

```
val sparkSession = SparkSession.builder().appName("ParqueJOB")
    .master("local[*]").getOrCreate()
```

```
val salesCSV = sparkSession.sqlContext.read.option("header","true")
    .csv("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/salessimple.csv")
```

```
salesCSV.write
    //.option("compression","snappy")
    .option("compression","gzip")
    .partitionBy("CookingGear","CampingEquipment")
    .parquet("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/sales_partition_gzip.parquet")
```

Parquet

```
val sparkSession = SparkSession.builder().appName("ParqueJOB")
    .master("local[*]").getOrCreate()
```

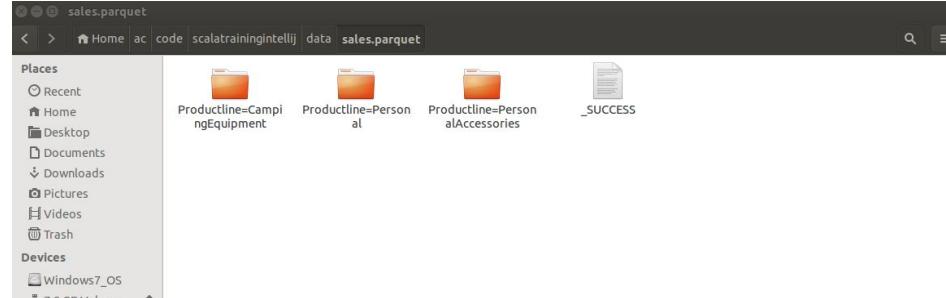
```
val salesCSV = sparkSession.sqlContext.read.option("header","true")
    .csv("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/salessimple.csv")
```

```
salesCSV.write
    //.option("compression","snappy")
    .option("compression","gzip")
    .partitionBy("CookingGear","CampingEquipment")
    .parquet("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/sales_partition_gzip.parquet")
```

Parquet

```
val salesCSV = sparkSession.sqlContext.read.option("header","true")  
.csv("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/salessimple.csv")
```

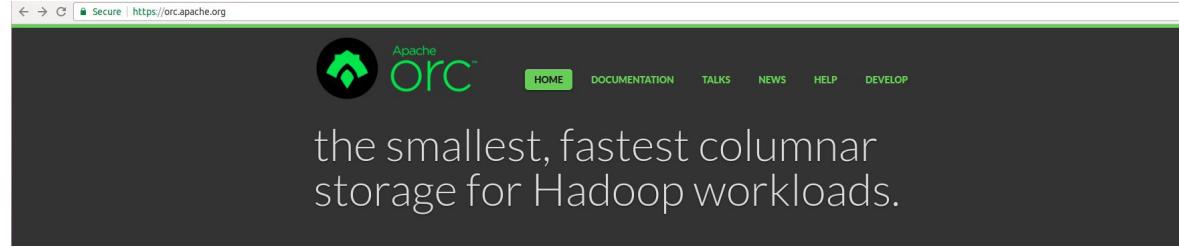
```
salesCSV.write.partitionBy("Productline")  
.parquet("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/sales.parquet")
```



Apache ORC

Apache ORC

Apache ORC is the Optimized Row Columnar format for the Big Data.



Apache ORC

```
val salesCSV = sparkSession.sqlContext.read.option("header","true")
.csv("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/salessimple.csv")

salesCSV.write.orc("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/saless
_partitions.orc")
```

Apache ORC



Spark Performance Tuning

Keep your memory always occupied and make it thinking about something.

Spark Performance Tuning

- ~ Try to avoid sending large amounts of data to the driver program. For eg., the collect() operation sends in data to the driver program.
- ~ Process data in the workers not in the driver. Instead store it in the hdfs.
- ~ Store large results in the hdfs
- ~ Use kryo serialization
- ~ Use accumulators and shared variables to share data.
- ~ Use Alluxio. It is now the top memory oriented storage.

Spark Performance Tuning

`spark.dynamicAllocation.enabled` By default false. Make it to true. Based on varying loads, enable the dynamic allocation to true.

Too much memory for the executor will increase overhead in Executor memory resulting in garbage collection.

Spark Performance Tuning

The default form of serialization, which is the java serialization and it is slow.
Kryo serializer solves in the performance issues of the basic serialization.

In order to enable kryo serialization, the "spark.serializer" configuration should be set to "org.apache.spark.serializer.KryoSerializer" in spark configuration as shown below.

```
SparkConf sparkConfig = new SparkConf()  
    .set("spark.serializer", "org.apache.spark.serializer.KryoSerializer")  
    .registerKryoClasses(new Class[]{TitanicBean.class})  
    .setAppName("ReadFile")  
    .setMaster("local[8]");
```

Spark Performance Tuning

If an RDD, will be used multiple times, persist to avoid recomputation. After done, unpersist the data whenever not required.

```
JavaRDD<String> persistedRDD = rdd.persist(StorageLevel.DISK_ONLY());
```

```
<<some operation on persistedRDD>>
```

```
persistedRDD.unpersist();
```

Compress your broadcast data

`spark.broadcast.compress = true`

By default it is true. But make it false, when you are using too much broadcasting.
You can minimize the cost to decompress.

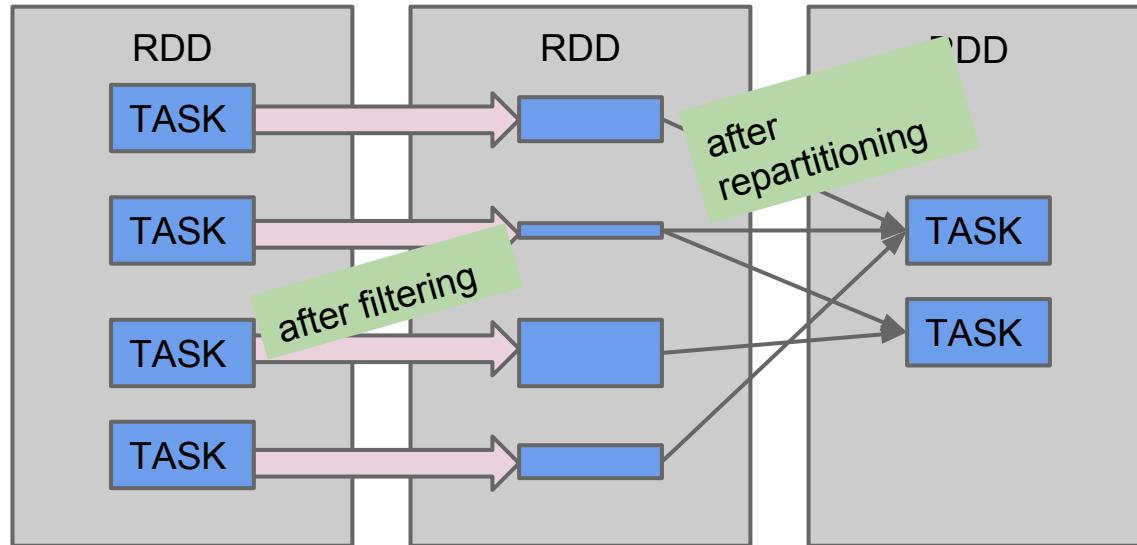
Varies from use case to use case.

Spark Performance Tuning

Filter can result in data with small partitions. So repartition() it.

```
JavaRDD<String> rdd = javaSparkContext.textFile("file:///Users/apple/undata1.csv");
```

```
rdd.filter(param -> param.split(",")[0].equals("\"India\""))
.repartition(2)
.foreach(System.out::println);
```



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Spark Performance Tuning

Don't pass in large amounts of data into function transformations.

```
Map<Integer, String> hugeHashMap = new HashMap<>();  
hugeHashMap.put(1, "Turing");  
hugeHashMap.put(...)  
  
rdd.map(new Function<String, String>() {  
  
    @Override  
    public String call(String arg0) throws Exception {  
        System.out.println(hugeHashMap.get(1));  
        .....  
    }  
  
}).count();
```

Spark Performance Tuning

Don't pass in large amounts of data into parallel functions,
Instead
use broadcast or parallelize to a RDD.

```
javaSparkContext.parallelizePairs(list)
```

```
javaSparkContext.parallelize(list)
```

Spark Performance Tuning

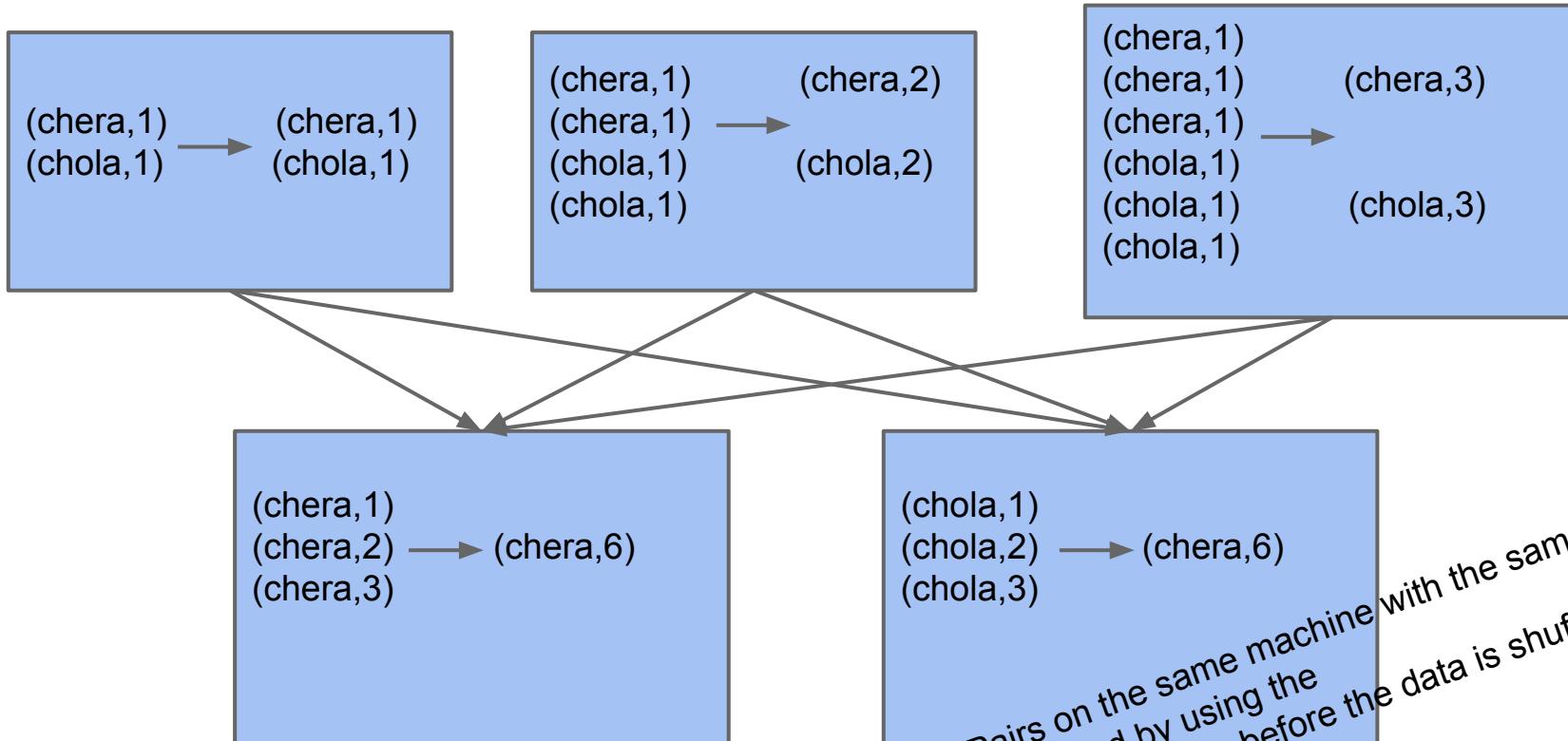
Be cautious when using `groupByKey()` instead use `reduceByKey()`.

`reduceByKey()` - Combines the output with a common key on each partition before shuffling. The pairs on the same machine with the same key are combined before shuffling happens.

`groupByKey()` - in case of `groupByKey()` all key-value pairs are shuffled around with lot of unnecessary data being transferred over the network.

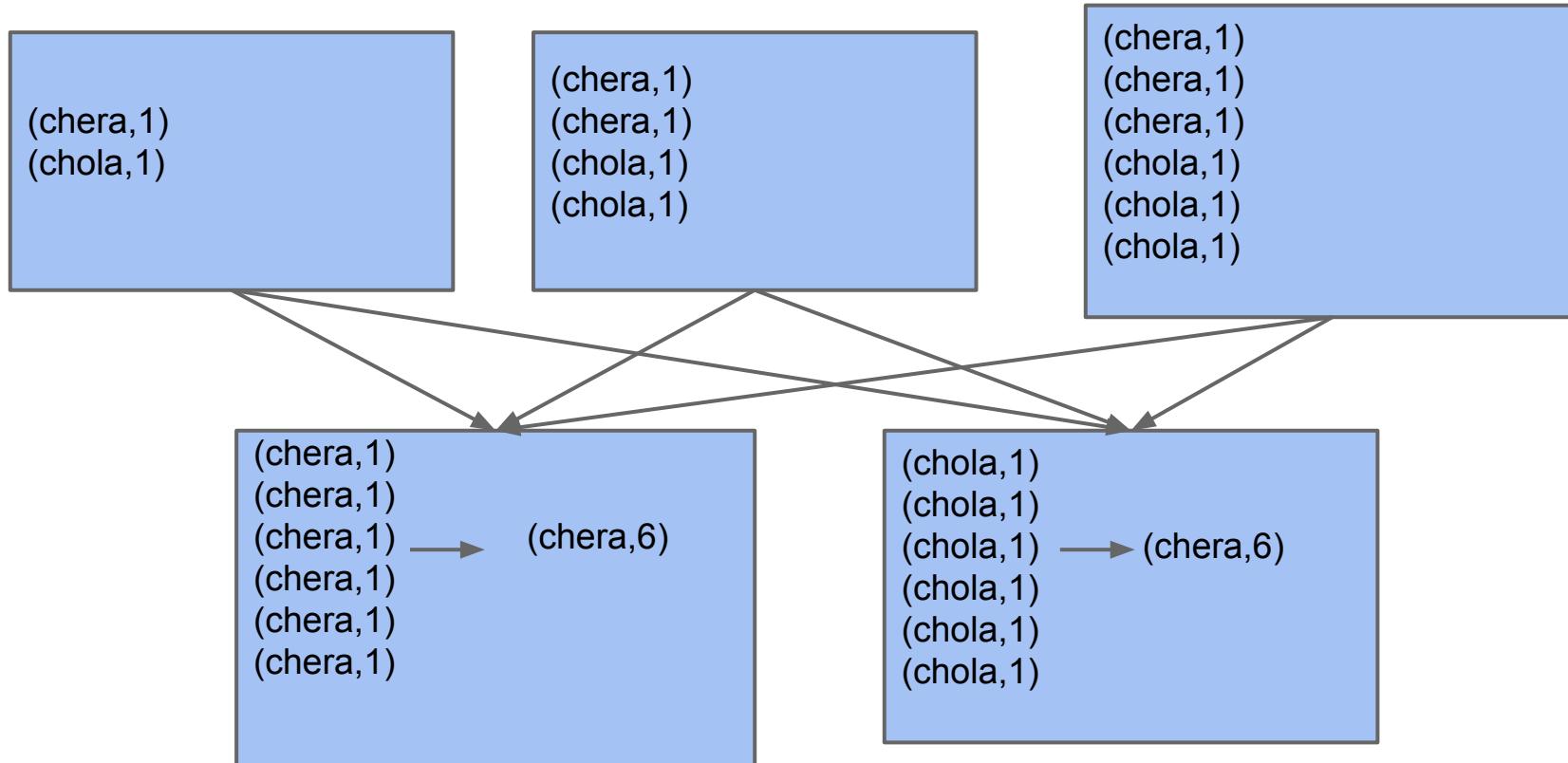
Spark Performance Tuning

reduceByKey()



Spark Performance Tuning

groupByKey()



Spark Performance Tuning

Stages for All Jobs

Active Stages: 1

Completed Stages: 1

Active Stages (1)

Stage Id	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Output	Shuffle Read	Shuffle Write
1	count at SparkInternals.java:43	+details (kill)	2015/09/20 12:56:54	1.8 min	0/2		1063.0 B	

Completed Stages (1)

Stage Id	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Output	Shuffle Read	Shuffle Write
0	mapToPair at SparkInternals.java:26	+details	2015/09/20 12:56:54	0.1 s	2/2	407.0 B		1063.0 B

Details for Stage 1 (Attempt 0)

Total Time Across All Tasks: 0 ms

Shuffle Read: 1063.0 B / 58

- ▶ DAG Visualization
- ▶ Show Additional Metrics
- ▶ Event Timeline

Summary Metrics for 0 Completed Tasks

No tasks have reported metrics yet.

Aggregated Metrics by Executor

Executor ID	Address	Task Time	Total Tasks	Failed Tasks	Succeeded Tasks	Shuffle Read Size / Records
driver	localhost:58034	0 ms	0	0	0	1063.0 B / 58

Tasks

Index	ID	Attempt	Status	Locality Level	Executor ID / Host	Launch Time	Duration	GC Time	Shuffle Read Size / Records	Errors
0	2	0	RUNNING	PROCESS_LOCAL	driver / localhost	2015/09/20 12:56:54	2.4 min	0 s	523.0 B / 26	
1	3	0	RUNNING	PROCESS_LOCAL	driver / localhost	2015/09/20 12:56:54	2.4 min	0 s	540.0 B / 32	

Spark Performance Tuning

Total Time Across All Tasks: 92 ms

Input Size / Records: 407.0 B / 29

Shuffle Write: 1063.0 B / 58

- ▶ DAG Visualization
- ▶ Show Additional Metrics
- ▶ Event Timeline

Summary Metrics for 2 Completed Tasks

Metric	Min	25th percentile	Median	75th percentile	Max
Duration	46 ms	46 ms	46 ms	46 ms	46 ms
GC Time	0 ms	0 ms	0 ms	0 ms	0 ms
Input Size / Records	203.0 B / 14	203.0 B / 14	204.0 B / 15	204.0 B / 15	204.0 B / 15
Shuffle Write Size / Records	417.0 B / 19	417.0 B / 19	646.0 B / 39	646.0 B / 39	646.0 B / 39

Task Duration should be even

Aggregated Metrics by Executor

Executor ID	Address	Task Time	Total Tasks	Failed Tasks	Succeeded Tasks	Input Size / Records	Shuffle Write Size / Records
driver	localhost:58034	0.2 s	2	0	2	407.0 B / 29	1063.0 B / 58

Tasks

Index	ID	Attempt	Status	Locality Level	Executor ID / Host	Launch Time	Duration	GC Time	Input Size / Records	Write Time	Shuffle Write Size / Records	Errors
0	0	0	SUCCESS	PROCESS_LOCAL	driver / localhost	2015/09/20 12:56:54	46 ms		203.0 B (hadoop) / 14	11 ms	646.0 B / 39	
1	1	0	SUCCESS	PROCESS_LOCAL	driver / localhost	2015/09/20 12:56:54	46 ms		204.0 B (hadoop) / 15	11 ms	417.0 B / 19	

Spark Performance Tuning

Total Time Across All Tasks: 92 ms

Input Size / Records: 407.0 B / 29

Shuffle Write: 1063.0 B / 58

- ▶ DAG Visualization
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Summary Metrics for 2 Completed Tasks

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Input Size / Records	203.0 B / 14	203.0 B / 14	204.0 B / 15	204.0 B / 15	204.0 B / 15
Shuffle Write Size / Records	417.0 B / 19	417.0 B / 19	646.0 B / 39	646.0 B / 39	646.0 B / 39

Task Duration should be even

Aggregated Metrics by Executor

Executor ID	Address	Task Time	Total Tasks	Failed Tasks	Succeeded Tasks	Input Size / Records	Shuffle Write Size / Records
driver	localhost:58034	0.2 s	2	0	2	407.0 B / 29	1063.0 B / 58

Tasks

Index	ID	Attempt	Status	Locality Level	Executor ID / Host	Launch Time	Duration	GC Time	Input Size / Records	Write Time	Shuffle Write Size / Records	Errors
0	0	0	SUCCESS	PROCESS_LOCAL	driver / localhost	2015/09/20 12:56:54	46 ms		203.0 B (hadoop) / 14	11 ms	46.0 B / 39	
1	1	0	SUCCESS	PROCESS_LOCAL	driver / localhost	2015/09/20 12:56:54	46 ms		204.0 B (hadoop) / 15	11 ms	417.0 B / 19	

Write time should not be big

Spark Data Locality

Data locality is nothing but the distance between the code and the data. Types of data locality are:

PROCESS_LOCAL

NODE_LOCAL

NODE_PREF

RACK_LOCAL

ANY

Spark Data Locality

spark.locality.wait

spark.locality.process

spark.locality.wait.node

spark.locality.wait.rack

Spark Best Practice

```
val config = new SparkConf()
config.setMaster("local")
config.setAppName("DatasetElucidation")

val sc = new SparkContext(config)

require(sc.version.replace(".", "").toInt >= 160,
        "Spark version should be 1.6+ or greater")
```

Always check for the spark version using the require, because the API use should be in compatible with the spark version installation.

Connecting to cassandra

```
<dependency>
    <groupId>com.datastax.spark</groupId>
    <artifactId>spark-cassandra-connector_2.10</artifactId>
    <version>1.6.0-M1</version>
</dependency>
```

Connecting to cassandra

```
SparkConf conf = new SparkConf();
    conf.setAppName("SparkCassandra");
    conf.setMaster("local[8]");
    conf.set("spark.cassandra.connection.host", "localhost");

CassandraConnector connector = CassandraConnector.apply(conf);
Session session = connector.openSession();
session.execute("CREATE KEYSPACE uidai WITH replication = {'class': 'SimpleStrategy',
                                                    'replication_factor': 3}");

session.execute("CREATE TABLE uidai.resident_detail (id INT PRIMARY KEY, name TEXT)");
session.close();
```

Connecting to Elastic Search

```
import org.elasticsearch.spark._

val supportVectorList = List(SVMSupportVector("mesh", "12", 1),
                             SVMSupportVector("maille", "15", 2),
                             SVMSupportVector("referential", "33", 2))

// pairrdd.saveToEs("spark2/data")
val rdd = sparkContext.makeRDD(supportVectorList)

EsSpark.saveToEs(rdd, "spark99/svmIndex")
// rdd.saveToEs("spark99/svmIndex")
```

Connecting to Elastic Search

```
val supportVectorList = List(SVMSupportVector("mesh", "12", 1),  
    SVMSupportVector("maille", "15", 2),  
    SVMSupportVector("referential", "33", 2))  
  
val rdd = sparkContext.makeRDD(supportVectorList)
```

Spark writes only a RDD to elastic search

That RDD should only be a case class or a Map. If any other object form has to be written then the ValueWriter class should be implemented.

Connecting to Elastic Search

```
<dependency>
<groupId>org.elasticsearch</groupId>
<artifactId>elasticsearch-spark-20_2.11</artifactId>
<version>5.2.0</version>
</dependency>
```

Connecting to ElasticSearch

localhost:9200/_search

Apps Difference between... Using JConsole - J... Spring Interview Qu... Hibernate Interview... hadoop Hibernate Interview... 201 Core Java Inter... Real Estate Forum... Other Bookmarks

```
{"took":2,"timed_out":false,"_shards":{"total":30,"successful":30,"failed":0},"hits":{"total":11,"max_score":1.0,"hits":[{"_index":"spark3","_type":"dd","_id":"AVpCVASKKeibdPl0xbpQ","_score":1.0,"_source":{"departure":"OTP","arrival":"SFO"}}, {"_index":"spark99","_type":"svmIndex","_id":"AVpEvUoIKEibdPl0xbpn","_score":1.0,"_source":{"name":"mesh","feature":12,"id":1}}, {"_index":"spark99","_type":"svmIndex","_id":"AVpEvUoIKEibdPl0xbpo","_score":1.0,"_source":{"name":"maille","feature":15,"id":2}}, {"_index":"ss","_type": "dd", "_id": "AVpCY9W-KeibdPl0xbpg", "score": 1.0, "source": {"departure": "OTP", "arrival": "SFO"}}, {"_index": "spark3", "type": "dd", "id": "AVpCVASKKeibdPl0xbpR", "score": 1.0, "source": {"name": "mesh", "feature": 12, "id": 1}}, {"_index": "MUC", "arrival": "OTP"}, {"_index": "spark99", "type": "svmIndex", "id": "AVpEvGJ3KeibdPl0xbpk", "score": 1.0, "source": {"name": "mesh", "feature": 12, "id": 1}}, {"_index": "spark99", "type": "svmIndex", "id": "AVpEvGJ3KeibdPl0xbpm", "score": 1.0, "source": {"name": "referential", "feature": 33, "id": 2}}, {"_index": "spark3", "type": "ss", "id": "AVpCT-NwKeibdPl0xbpM", "score": 1.0, "source": {"departure": "MUC", "arrival": "OTP"}}, {"_index": "spark3", "type": "ss", "id": "AVpCT-NwKeibdPl0xbpl", "score": 1.0, "source": {"departure": "OTP", "arrival": "SFO"}}, {"_index": "spark99", "type": "svmIndex", "id": "AVpEvGJ3KeibdPl0xbpl", "score": 1.0, "source": {"name": "maille", "feature": 15, "id": 2}}]}}}
```



chinna samyad@gmail.com

AVRO 903

Avro Encoding

```
public byte[] encode(MyMessage myMessage) {  
  
    final ByteArrayOutputStream baos = new ByteArrayOutputStream();  
    final DatumWriter<MyMessage> writer = new ReflectDatumWriter(MyMessage.class);  
  
    try (DataFileWriter<MyMessage> out = new DataFileWriter(writer))  
    {  
  
        out.setCodec(CodecFactory.bzip2Codec()).create(ReflectData.get().getSchema(MyMessage.class), baos);  
        out.append(myMessage);  
    }  
    catch (final IOException exception) {  
  
    }  
  
    return baos.toByteArray();  
}
```

Avro Decoding

```
public MyMessage decode(byte[] bytes) {  
  
    MyMessage myMessage = null;  
  
    final ByteArrayInputStream bais = new ByteArrayInputStream (bytes);  
  
    final DatumReader<MyMessage> reader = new  
        ReflectDatumReader<IPROMessage>(ReflectData.get().getSchema(MyMessage.class));  
  
    try (final DataFileStream<MyMessage> dfs = new DataFileStream<MyMessage> (bais, reader);)  
    {  
        myMessage = dfs.next (myMessage);  
  
    } catch (final IOException exception) {  
  
    }  
  
    return myMessage;  
}
```

Structured Streaming

Next Generation Streaming API

Evolution of Streaming

Everything is streaming now !!!

The web today : everything is streaming. From Twitter Trends to Football match.

Stream processing was viewed as a low latency batch processing.

Eg: Storm, Spark DStreams.

Storm took stateless per message and spark took minibatch approach.

Spark 1.x streaming feels like streaming.

Limited state workloads with DStreams.

Evolution of Streaming

New way of looking at streaming:

Stream becomes the default abstraction on which both stream processing and batch processing is built.

Stream processing is the default. Batch processing is looked at as a bounded stream.

Everything is Stream and make batch processing as a part of it.

Eg: Flink, Beam

DStream API - Limitations

DStreamAPI is a fast batch processing in runtime and API.

Batch time dictates how different abstractions of API - window and state events.

No support for time based abstraction.

Structured Streaming

Introduced in Spark 2.0. From Spark 2.2, it has been a stable component.

Models stream as an *infinite table* rather than discretized stream of data.

Infinite table aka Infinite Dataset

Support on time based abstraction. Ingestion time, event time.

Spark 1.x streaming was based upon *RDD* based stream processing,
but Spark 2.0 is based upon *Dataset* based streaming.

Structured Streaming

As we are using structured abstraction, it's called structured streaming API.

Structured streaming is a fault tolerant engine built on top of Spark SQL engine.

All input sources, stream transformations and output sinks are modeled as Dataset.

The Dataset API's are used heavily to process it.

Easy to combine with batch data as both use same Dataset abstraction.

Structured Streaming is a fast and fault tolerant streaming which guarantees end-to-end exactly once stream processing.

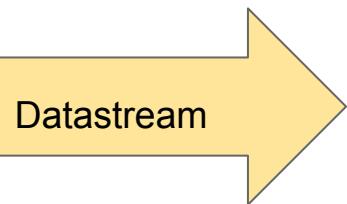
Structured Streaming

Structured Streaming uses the approach of computing on streaming as considering it as not streams but as tables, computing through DataFrame/Dataset API.

Structured Streaming utilizes Catalyst optimizer to compute on the infinite incremental execution of the data.

When viewed deeply, the streaming can be simplified as an *infinite table*.

Structured Streaming



UN-BOUNDED TABLE				
Data	Data	Data	Data	Data

Data	Data	Data	Data	Data
------	------	------	------	------

Data	Data	Data	Data	Data
------	------	------	------	------

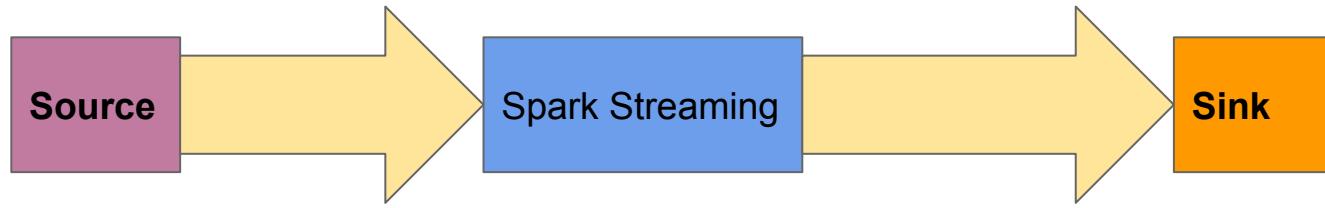
Source and Sinks API

Source - Socket

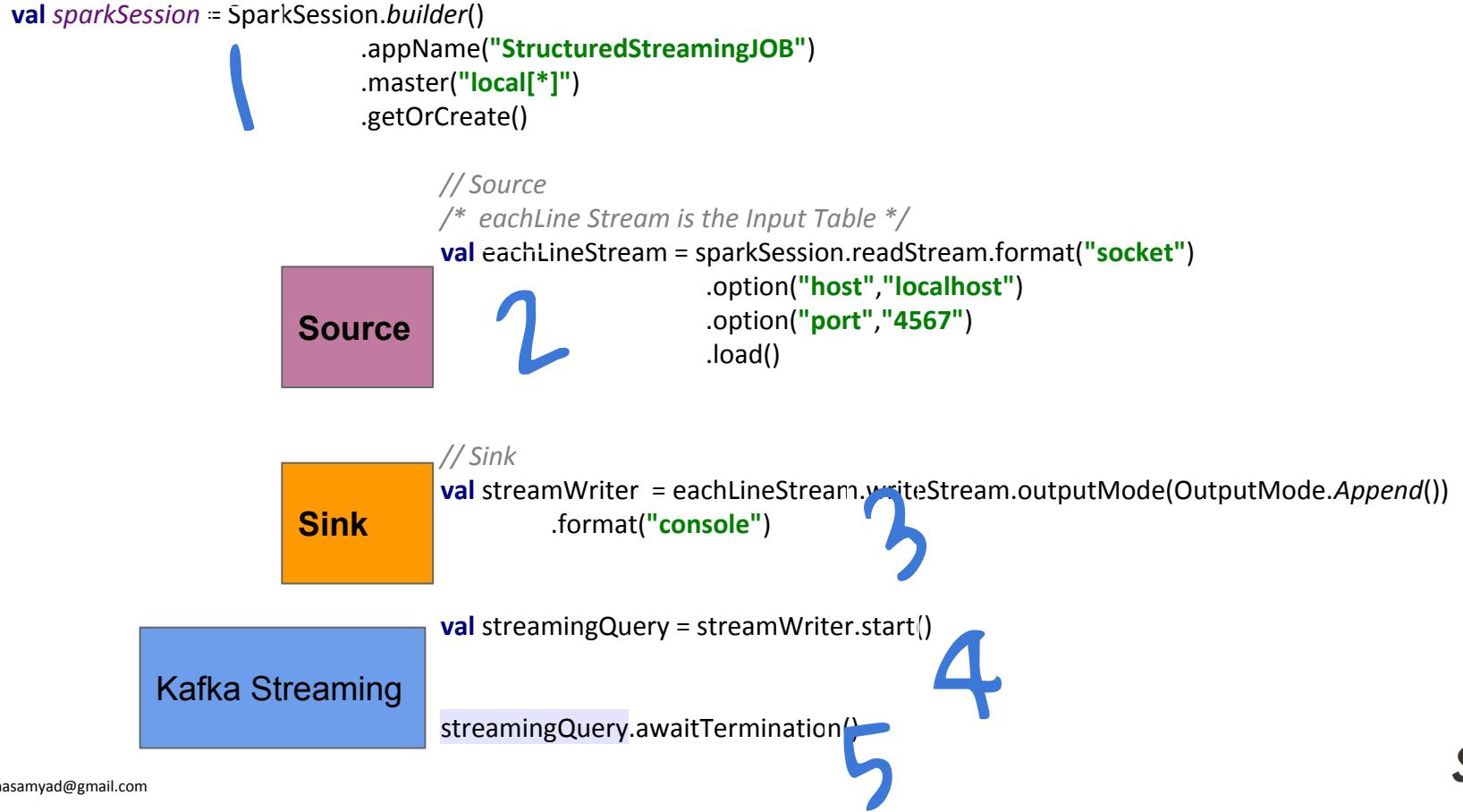
Sink - Console

For socket stream, when you read a socket, it returns a Dataframe with single column value.

Structured Streaming



Structured Streaming



Structured Streaming

No batch time

Process it ASAP. Meaning on ProcessingTime(0)

awaitTermination is on query. Meaning that can have multiple queries running parallelly.

The NEW API but the same runtime.

In future, the spark streaming would come with a new runtime for streaming in spark.

Structured Streaming

```
val sparkSession = SparkSession.builder()
    .appName("StructuredStreamingMultiplierJOB")
    .master("local[*]")
    .getOrCreate()

/* eachLine Stream is the Input Table */
val eachLineStream = sparkSession.readStream.format("socket")
    .option("host", "localhost")
    .option("port", "4567")
    .load()

import sparkSession.implicits._

// Result Table
val eachRow = eachLineStream.as[String].map(Integer.parseInt(_) * 3)

val finalReckoner = eachRow.writeStream.outputMode("append").format("console").start()

finalReckoner.awaitTermination()
```

Structured Streaming - Stateful operations

Structured Streaming - all aggregations are stateful by default.

Spark internally uses both disk and memory to remember state.

No more complicated state management in application code.

Structured Streaming

Output mode

Complete Mode - The entire Result Table will be flushed (written) to the external storage.

Append Mode - The new rows appended to the Result Table since the last trigger will be written to the external storage.

Update Mode - The rows that were updated in Result Table since the last trigger will be written to the external storage.

Stateful vs Stateless

flatMapGroups

Checkpointing and state recovery

File Stream

Structured streaming has support for file based streams.

CSV, JSON, Parquet are supported by default.

Tachyon

<http://tachyon-project.org/>



TACHYON

What is tachyon ?

A distributed storage system at memory speed across cluster frameworks.

Configuring tachyon

[1] Create the tachyon-env.sh from the template in the conf directory

```
cp /tachyon071/conf/tachyon-env.sh.template /tachyon071/conf/tachyon-env.sh
```

[2] Format the tachyon.

```
./bin/tachyon format
```

[3] Start the tachyon

```
./tachyon-start.sh local
```

[4] Stop tachyon

```
./bin/tachyon-stop.sh
```

Data in tachyon

Like HDFS we also have tachyon command line

./tachyon tfs ls /

List

./tachyon tfs mkdir /chin

Make Directory

./tachyon tfs copyFromLocal /Users/apple/titanic3.csv /

Copy File

./tachyon tfs cat /chin/titanic3.csv

Display file

Tachyon Configurations

By default tachyon runs in port 19998 and tachyon UI starts in port 19999.

Tachyon Advantages

Multiple executors share the same pool of memory in tachyon

By the above advantage, cached data is not lost when individual executors crash.

Garbage collection cost is reduced.

tachyon

When a grep on tachyon is done, it should show a TachyonMaster and TachyonWorker running as shown below.

```
Apples-MacBook-Pro:bin apple$ ps -ef | grep tachyon
 501 26958      1  0  4:00PM ??        0:01.11 /Library/Java/JavaVirtualMachines/jdk1.8.0_60.jdk/Contents/Home/bin/java -cp /Users/apple/tachyon071/conf/:/Users/apple/tachyon071/assembly/target/tachyon-assemblies-0.7.1-jar-with-dependencies.jar -Dtachyon.home=/Users/apple/tachyon071 -Dtachyon.logs.dir=/Users/apple/tachyon071/logs -Dtachyon.logger.type=W
0RKER_LOGGER -Dlog4j.configuration=file:/Users/apple/tachyon071/conf/log4j.properties -Djava.security.krb5.realm= -Djava.security.krb5.kdc= -Dlog4j.configuration=file:/Users/apple/tachyon071/conf/log4j.properties -Dtachyon.debug=false -Dtachyon.worker.tieredstore.level.max=1 -Dtachyon.worker.tieredstore.level0.alias=MEM -Dtachyon.worker.tieredstore.level0.dirs.path=/Volumes/ramdisk -Dtachyon.worker.tieredstore.level0.dirs.quota=1GB -Dtachyon.underfs.address=/Users/apple/tachyon071/underFSStorage -Dtachyon.underfs.hdfs.impl=org.apache.hadoop.hdfs.DistributedFileSystem -Dtachyon.data.folder=/Users/apple/tachyon071/underFSStorage/tmp/tachyon/data -Dtachyon.worker.max.worker.threads=2048 -Dtachyon.workers.folder=/Users/apple/tachyon071/underFSStorage/tmp/tachyon/workers -Dtachyon.worker.memory.size=1GB -Dtachyon.worker.data.folder=/tachyonworker/ -Dtachyon.master.max.worker.threads=2048 -Dtachyon.master.worker.timeout.ms=60000 -Dtachyon.master.hostname=localhost -Dtachyon.master.journal.folder=/Users/apple/tachyon071/journal/ -Dorg.apache.jasper.compiler.disablejsr199=true -Djava.net.preferIPv4Stack=true tachyon.worker.TachyonWorker
 501 24609      1  0  3:23PM ttys000    0:07.68 /Library/Java/JavaVirtualMachines/jdk1.8.0_60.jdk/Contents/Home/bin/java -cp /Users/apple/tachyon071/conf/:/Users/apple/tachyon071/assembly/target/tachyon-assemblies-0.7.1-jar-with-dependencies.jar -Dtachyon.home=/Users/apple/tachyon071 -Dtachyon.logs.dir=/Users/apple/tachyon071/logs -Dtachyon.logger.type=M
ASTER_LOGGER -Dlog4j.configuration=file:/Users/apple/tachyon071/conf/log4j.properties -Djava.security.krb5.realm= -Djava.security.krb5.kdc= -Dlog4j.configuration=file:/Users/apple/tachyon071/conf/log4j.properties -Dtachyon.debug=false -Dtachyon.worker.tieredstore.level.max=1 -Dtachyon.worker.tieredstore.level0.alias=MEM -Dtachyon.worker.tieredstore.level0.dirs.path=/Volumes/ramdisk -Dtachyon.worker.tieredstore.level0.dirs.quota=1GB -Dtachyon.underfs.address=/Users/apple/tachyon071/underFSStorage -Dtachyon.underfs.hdfs.impl=org.apache.hadoop.hdfs.DistributedFileSystem -Dtachyon.data.folder=/Users/apple/tachyon071/underFSStorage/tmp/tachyon/data -Dtachyon.worker.max.worker.threads=2048 -Dtachyon.workers.folder=/Users/apple/tachyon071/underFSStorage/tmp/tachyon/workers -Dtachyon.worker.memory.size=1GB -Dtachyon.worker.data.folder=/tachyonworker/ -Dtachyon.master.max.worker.threads=2048 -Dtachyon.master.worker.timeout.ms=60000 -Dtachyon.master.hostname=localhost -Dtachyon.master.journal.folder=/Users/apple/tachyon071/journal/ -Dorg.apache.jasper.compiler.disablejsr199=true -Djava.net.preferIPv4Stack=true tachyon.master.TachyonMaster
```

tachyon UI

localhost:19999/home

TACHYON Overview Browse File System System Configuration Workers In-Memory Files Log Files Enable Auto-Refresh

Tachyon Summary

Master Address:	localhost/127.0.0.1:19998
Started:	09-29-2015 15:23:54:904
Uptime:	0 day(s), 0 hour(s), 0 minute(s), and 11 second(s)
Version:	0.7.1
Running Workers:	1

Cluster Usage Summary

Workers Capacity:	1024.00 MB
Workers Free / Used:	1024.00 MB / 0.00 B
UnderFS Capacity:	465.60 GB
UnderFS Free / Used:	431.22 GB / 34.38 GB

Storage Usage Summary

Storage Alias	Space Capacity	Space Used	Space Usage
MEM	1024.00 MB	0.00 B	100%Free

Tachyon is an [open source](#) project developed at the UC Berkeley [AMPLab](#).

tachyon UI

localhost:19999/configuration

TACHYON Overview Browse File System **System Configuration** Workers In-Memory Files Log Files Enable Auto-Refresh

Tachyon Configuration

tachyon.async.enabled	false
tachyon.data.folder	/Users/apple/tachyon071/underFSStorage/tmp/tachyon/data
tachyon.debug	false
tachyon.home	/Users/apple/tachyon071
tachyon.host.resolution.timeout.ms	5000
tachyon.logger.type	MASTER_LOGGER
tachyon.logs.dir	/Users/apple/tachyon071/logs
tachyon.master.address	tachyon://localhost:19998
tachyon.master.format.file_prefix	_format_
tachyon.master.heartbeat.interval.ms	1000
tachyon.master.hostname	localhost
tachyon.master.journal.folder	/Users/apple/tachyon071/journal/
tachyon.master.max.worker.threads	2048
tachyon.master.min.worker.threads	8
tachyon.master.port	19998



What is alluxio ?

A distributed storage system at memory speed across cluster frameworks. ie., it is a virtual memory distributed storage system.

Formerly tachyon. Baidu uses alluxio.

Alluxio is a intermediate storage guy in between hadoop frameworks. It can act as a intermediary between HBASE, MR, Spark etc.,

Why alluxio ?

Spark context might crash, so computing has to restart from beginning. Use alluxio !!!

Share data between spark jobs and also between many computing engines.

An added flavor for memory speed storage and computation.

Prepare alluxio first

Do bootstrap to prepare for the default configuration.

```
Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio bootstrapConf localhost  
/Users/dharshekthvel/ac/alluxio14/bin/..../conf/alluxio-env.sh is created.  
Dharshekths-MacBook-Pro:bin dharshekthvel$ █
```

Do format to prepare auxillo for storage.

```
Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio format  
Waiting for tasks to finish...  
All tasks finished, please analyze the log at /Users/dharshekthvel/ac/alluxio14/bin/..../logs/task.log.  
Formatting Alluxio Master @ Dharshekths-MacBook-Pro.local  
Dharshekths-MacBook-Pro:bin dharshekthvel$ █
```

Start alluxio server

```
[Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio-start.sh local
Waiting for tasks to finish...
All tasks finished, please analyze the log at /Users/dharshekthvel/ac/alluxio14/bin/..../logs/task.log.
Waiting for tasks to finish...
All tasks finished, please analyze the log at /Users/dharshekthvel/ac/alluxio14/bin/..../logs/task.log.
Killed 0 processes on Dharshekths-MacBook-Pro.local
Killed 0 processes on Dharshekths-MacBook-Pro.local
Starting master @ Dharshekths-MacBook-Pro.local. Logging to /Users/dharshekthvel/ac/alluxio14/logs
Formatting RamFS: ramdisk 22617129 sectors (10922mb).
Started erase on disk3
Unmounting disk
Erasing
Initialized /dev/rdisk3 as a 11 GB case-insensitive HFS Plus volume
Mounting disk
Finished erase on disk3 ramdisk
Starting worker @ Dharshekths-MacBook-Pro.local. Logging to /Users/dharshekthvel/ac/alluxio14/logs
Starting proxy @ Dharshekths-MacBook-Pro.local. Logging to /Users/dharshekthvel/ac/alluxio14/logs
Dharshekths-MacBook-Pro:bin dharshekthvel$ ]
```

Using alluxio shell to transfer data

```
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/bin$ ./alluxio fs copyFromLocal ~/ac/baahubali.mp4 /  
Copied file:///home/dharshekthvel/ac/baahubali.mp4 to /
```

After copying the file. Persist the file to the file system.

```
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/bin$ ./alluxio fs persist /baahubali.mp4  
persisted file /baahubali.mp4 with size 15131188
```

The file would be available in the local storage.

```
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/bin$ ls ..underFSStorage/  
baahubali.mp4
```

Using alluxio shell to transfer data

```
[Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio fs ls /
[Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio fs mkdir /dhara
Successfully created directory /dhara
[Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio fs ls /
drwxr-xr-x    dharshekthvel  staff      0.00B  02-03-2017 10:00:34:152  Directory      /dhara
Dharshekths-MacBook-Pro:bin dharshekthvel$ █
```

```
[Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio fs persist /dhara
```

Alluxio UI

Alluxio starts a UI by default at 19999

← → ⌂ ⓘ localhost:19999/home

 ALLUXIO Overview Browse Configuration Workers In-Memory Data Logs Metrics Enable Auto-Refresh

Alluxio Summary

Master Address:	localhost/127.0.0.1:19998
Started:	02-03-2017 09:59:39:500
Uptime:	0 day(s), 0 hour(s), 3 minute(s), and 27 second(s)
Version:	1.4.0
Running Workers:	1
Startup Consistency Check:	COMPLETE

Cluster Usage Summary

Workers Capacity:	10.67GB
Workers Free / Used:	10.67GB / 0.00B
UnderFS Capacity:	232.63GB
UnderFS Free / Used:	26.05GB / 206.57GB

Storage Usage Summary

Storage Alias	Space Capacity	Space Used	Space Usage
MEM	10.67GB	0.00B	100%Free

[Project Website](#) | [User Mailing List](#) | [User Survey](#) | [Resources](#)

Alluxio UI

Alluxio starts a UI by default at 19999

localhost:19999/browse?path=%2F&offset=0&limit=1

ALLUXIO Overview Browse Configuration Workers In-Memory Data Logs Metrics Enable Auto-Refresh

File Name	Size	Block Size	In-Memory	Mode	Owner	Group	Persistence State	Pin	Creation Time	Modification Time
baahubali.mp4	14.43MB	512.00MB	100%	-rw-r--r--	dharshekthvel	dharshekthvel	PERSISTED	NO	06-22-2017 11:11:14:800	06-22-2017 11:12:49:564

[View Settings](#)

Stop alluxio server

```
Dharshekths-MacBook-Pro:bin dharshekthvel$ ./alluxio-stop.sh all
Waiting for tasks to finish...
All tasks finished, please analyze the log at /Users/dharshekthvel/ac/alluxio14/bin/..../logs/task.log.
Waiting for tasks to finish...
All tasks finished, please analyze the log at /Users/dharshekthvel/ac/alluxio14/bin/..../logs/task.log.
Killed 1 processes on Dharshekths-MacBook-Pro.local
Killed 1 processes on Dharshekths-MacBook-Pro.local
Dharshekths-MacBook-Pro:bin dharshekthvel$ █
```

Underlying storage should be HDFS

In the conf directory of alluxio, copy the alluxio-site.properties.template to alluxio-site.properties and add the HDFS namenode URI to the alluxio-site.properties config file.

```
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/conf$ ls  
alluxio-env.sh      alluxio-site.properties      core-site.xml.template  masters          workers  
alluxio-env.sh.template  alluxio-site.properties.template  log4j.properties    metrics.properties.template
```

```
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/conf$ cp alluxio-site.properties.template alluxio-site.properties
```

```
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/conf$ ls  
alluxio-env.sh      alluxio-site.properties      core-site.xml.template  masters          workers  
alluxio-env.sh.template  alluxio-site.properties.template  log4j.properties    metrics.properties.template  
#  
# The Alluxio Open Foundation licenses this work under the Apache License, version 2.0  
# (the "License"). You may not use this work except in compliance with the License, which is  
# available at www.apache.org/licenses/LICENSE-2.0.  
#  
# This software is distributed on an "AS IS" basis, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND,  
# either express or implied, as more fully set forth in the License.  
#  
# See the NOTICE file distributed with this work for information regarding copyright ownership.  
#  
# Site specific configuration properties for Alluxio  
# Details about all configuration properties http://www.alluxio.org/documentation/en/Configuration-Settings.html  
# Common properties  
# alluxio.master.hostname=localhost  
# alluxio.underfs.address=${alluxio.work.dir}/underFSStorage  
# Security properties  
# alluxio.security.authorization.permission.enabled=true  
# alluxio.security.authentication.type=SIMPLE  
# Worker properties  
# alluxio.worker.memory.size=1GB  
# alluxio.worker.tieredstore.levels=1  
# alluxio.worker.tieredstore.level0.alias=MEM  
# alluxio.worker.tieredstore.level0.dirs.path=/mnt/ramdisk  
# User properties  
# alluxio.user.file.readtype.default=CACHE_PROMOTE  
# alluxio.user.file.writetype.default=MUST_CACHE  
alluxio.underfs.address=hdfs://localhost:9080  
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/conf$
```

Alluxio Load Data from Underlying Storage

```
dharshekthvel@dharshekthvel:~/ac/bin/alluxio-1.5.0-hadoop-2.8/bin$ ./alluxio fs load /GateNLP.pdf  
/GateNLP.pdf loaded
```

In the screen-shot, you can see the In-memory being 100%. By which the GATENLP.pdf is loaded in memory.

File Name	Size	Block Size	In-Memory	Mode	Owner	Group	Persistence State	Pin	Creation Time	Modification Time
GateNLP.pdf	5.07MB	128.00MB	100%	-rw-r--r--	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:521	06-22-2017 11:26:48:524
IMG-20161219-WA0030.jpg	100.29KB	128.00MB	0%	-rw-r--r--	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:529	06-22-2017 11:26:48:529
Test.tar.gz	63.71KB	128.00MB	0%	-rw-r--r--	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:531	06-22-2017 11:26:48:531
a.txt	3.00B	128.00MB	100%	-rw-r--r--	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:534	06-22-2017 11:26:48:534
arav				drwxr-xr-x	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:535	06-22-2017 11:26:48:535
baahubali.mp4	14.43MB	512.00MB	0%	-rw-r--r--	dharshekthvel	dharshekthvel	PERSISTED	NO	06-22-2017 11:11:14:800	06-22-2017 11:12:49:564
chinnasamy				drwxr-xr-x	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:541	06-22-2017 11:26:48:541
county.pkl	33.00B	512.00MB	100%	-rw-r--r--	dharshekthvel	dharshekthvel	PERSISTED	NO	06-22-2017 11:37:12:636	06-22-2017 11:37:29:504
covtype.info	14.27KB	128.00MB	0%	-rw-r--r--	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:544	06-22-2017 11:26:48:545
history_1.txt	21.59KB	128.00MB	0%	-rw-r--r--	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:547	06-22-2017 11:26:48:547
mapred.cmd	6.16KB	128.00MB	0%	-rw-r--r--	dharshekthvel	supergroup	PERSISTED	NO	06-22-2017 11:26:48:549	06-22-2017 11:26:48:549

View Settings

Number of items per page:

Maximum number of pages to show in pagination component:

L[↔]VY

LIVY

Open source rest service for Apache Spark.

<http://livy.io>

Livy by default starts in port 8998

LIVY

Livy needs SPARK_HOME to be set. Ensure that the SPARK_HOME variable is set.

Goto `livy_installation/bin` directory,
Start the server using `./livy-server`

```
eknivenet@dharshekthvel:~/home/dharshekthvel/ac/bin/livy-server030/bin$ ls
dharshekthvel@dharshekthvel:/home/dharshekthvel/ac/bin/livy-server030/bin
dharshekthvel@dharshekthvel:~/ac/bin/livy-server030/bin$ ./livy-server
dharshekthvel@dharshekthvel:~/ac/bin/livy-server030/bin$ ./livy-server
17/03/11 13:52:39 INFO StateStore$: Using BlackholeStateStore for recovery.
17/03/11 13:52:39 INFO BatchSessionManager: Recovered 0 batch sessions. Next session id: 0
17/03/11 13:52:39 INFO InteractiveSessionManager: Recovered 0 interactive sessions. Next session id: 0
17/03/11 13:52:39 INFO InteractiveSessionManager: Heartbeat watchdog thread started.
17/03/11 13:52:39 INFO WebServer: Starting server on http://dharshekthvel:8998
```

LIVY

The screenshot shows the Advanced REST client (ARC) interface. On the left, there's a sidebar with 'ARC' at the top, followed by 'HTTP request', 'Socket', 'History', 'Saved', and 'Projects'. The main area has a title 'Request' with a URL input field containing 'http://localhost:8998/metrics'. Below it, a method dropdown shows 'GET' selected. To the right are tabs for 'Raw headers', 'Headers form', 'Headers sets', and 'Variables'. A large text area displays the JSON response: { "version": "3.0.0", "gauges": {}, "counters": {}, "histograms": {}, "meters": {}, "timers": {} }. At the bottom, there are buttons for 'Raw' and 'JSON', and a status bar indicating '200 OK 7.00 ms'.



Livy REST CALLS

<http://localhost:8998/sessions>

```
{  
    "from": 0,  
    "total": 0,  
    "sessions": [],  
}
```

<http://localhost:8998/metrics>

```
{  
    "version": "3.0.0",  
    "gauges": {},  
    "counters": {},  
    "histograms": {},  
    "meters": {},  
    "timers": {}  
}
```

<http://localhost:8998/ping> - Returns PONG

chinnasamyad@gmail.com



Livy REST CALLS

POST : <http://localhost:8998/sessions>

```
{"kind":"spark",
"proxyUser":"",
"jars":[],
"pyFiles":[],
"files":[],
"driverMemory":"1G",
"driverCores":8,
"executorMemory":"",
"executorCores":4,
"numExecutors":2,
"archives":[],
"queue":"",
"name":"SparkJOBSession",
"conf":{},
"heartbeatTimeoutInSecond":10}
```

Spark GraphX

Spark GraphX

A directed graph with vertex and edges and computations happening on RDD level

Spark ML

Machine Learning

Types of learning

Supervised Learning

Unsupervised Learning

Spark ML - Linear Regression

A learning algorithm to learn relation between dependent variable (y) with one or more explanatory variable (x) which are connected by the linear relation.

The hypothesis for the linear regression is as follows

$$h(x) = c_1.(x_1) + c_2.(x_2) + c_3.(x_3) + \dots$$

x_1, x_2, x_3, \dots are the explanatory variables. $h(x)$ is the hypothesis.

Linear regression goal is to learn c_1, c_2, c_3, \dots

Spark ML - Decision Trees

Decision tree is a flowchart like structure, where any node is a if-check on the attribute formed from the data.

Decision trees are used in predicting a target variable based on the input data.

Spark ML - Decision Trees

```
import org.apache.spark.mllib.tree.DecisionTree;
import org.apache.spark.mllib.tree.model.DecisionTreeModel;
```

```
DecisionTreeModel dtm =
    DecisionTree.trainClassifier(trainingData, 2, categoricalFeaturesInfo, impurity, maxDepth, maxBins);

dtm.predict(features);
```

Spark Future

Project Tungsten - Memory and CPU efficiency tuning

Spark and R - Already done. But more robust API's.

Off heap memory management - Tachyon

Spark Future - Road Ahead

SuccintRDD - Querying on the compressed Data.

<https://github.com/amplab/succinct>

Velox Model Server - Predictions on data.

<https://github.com/amplab/velox-modelserver>

Project

1. First spark batch job, let it read the dataset and publish to a queue
2. The second streaming job, read from the queue and write it to cassandra.
3. Use the agriculture dataset

Spark Future - Road Ahead

SuccintRDD - Querying on the compressed Data

Velox Model Server

PySpark

Writing Apache Spark in Python

chinna samyad@gmail.com

textFile transformation

The base Pyspark program

```
from pyspark import SparkConf
from pyspark import SparkContext

sparkconfig = SparkConf()
sparkconfig.setMaster("local[*]")
sparkconfig.setAppName("SparkCSVJOB")

def print_each_line(eachLine):
    print eachLine
    return

sparkcontext = SparkContext(conf= sparkconfig)

textFileRDD = sparkcontext.textFile("/home/dharshekthvel/Downloads/query_result.csv")

textFileRDD.foreach(print_each_line)
```

Spark_context - parallelize

```
from __future__ import print_function
from pyspark.conf import SparkConf
from pyspark.context import SparkContext

config = SparkConf()
config.setMaster("local[*]")
config.setAppName("ParallelizeJOB")

sc = SparkContext(conf=config)
dataRDD = sc.parallelize([100,200,300,400])

#<class 'pyspark.rdd.RDD'>
print(type(dataRDD))

dataRDD.foreach(lambda eachElement: print(eachElement))
```

Spark Session

The Spark_Session is the umbrella API for the SparkContext, SQLContext and StreamingContext.

```
from pyspark.sql.session import SparkSession
```

```
def g(x): print(x)
```

```
ss = SparkSession.builder.appName("SparkJOB").master("local[*]").getOrCreate()
```

```
sc = ss.sparkContext
```

```
textRDD = sc.parallelize([10,20,30])
```

```
textRDD.foreach(g)
```

Spark - Storage Levels

```
textFileRDD = sc.textFile("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/document.txt")
```

```
textFileRDD.persist(StorageLevel.MEMORY_AND_DISK)  
textFileRDD.unpersist()
```

Accumulator

```
def print_each_line(eachLine):
    print (eachLine)
    return

sparkcontext = SparkContext(conf= sparkconfig)

date_accumulator = sparkcontext.accumulator(0)

textFileRDD = sparkcontext.textFile("/home/dharshekthvel/Downloads/query_result.csv")

textFileRDD.map(lambda each : each.split(","))
.map(lambda each: date_accumulator.add(1) if each[0]=="20170103" else date_accumulator.add(0))
.collect()

print (date_accumulator.value)
```

Broadcast

```
def compute_each_line(eachLine):

    # Fetching the broadcast that is sent by the master
    date_code = date_code_broadcast.value

    data_split = eachLine.split(",")

    if data_split[0] in date_code:
        print(eachLine)

    return

sparkcontext = SparkContext(conf= sparkconfig)

// Creation of broadcast
date_code_broadcast = sparkcontext.broadcast(["20170104", "20170102"])

textFileRDD = sparkcontext.textFile("/home/dharshekthvel/Downloads/query_result.csv")

textFileRDD.map(compute_each_line).collect()
```

Spark - WordCount in Spark

```
from __future__ import print_function

from pyspark.conf import SparkConf
from pyspark.context import SparkContext
from pyspark.storagelevel import StorageLevel

config = SparkConf()
config.setMaster("local[*]")
config.setAppName("WORD_COUNT_JOB")

sc = SparkContext(conf=config)

textFileRDD = sc.textFile("/home/dharshekthvel/Desktop/ac/code/scalatrainingintellij/data/document.txt")

count_of_words = textFileRDD.flatMap(lambda each: each.split(' '))\
    .map(lambda each: (each,1))\
    .reduceByKey(lambda a,b:a+b).collect()

for (word,count) in count_of_words:
    print("%s - %s" % (word,count))
```

```
from pyspark import SparkConf
from pyspark import SparkContext
from pyspark.sql import SQLContext
from pyspark.sql.types import IntegerType

sparkconfig = SparkConf()
sparkconfig.setMaster("local[*]")
sparkconfig.setAppName("SparkCSVJOB")

def print_each_line(eachLine):
    print eachLine
    return

sparkcontext = SparkContext(conf= sparkconfig)
sqlContext = SQLContext(sparkcontext)

sqlContext.udf.register("STRING_LENGTH", lambda s: len(s), IntegerType())

csvDF = sqlContext.read \
    .option("header", "true") \
    .csv("/home/dharshekthvel/Downloads/stop.csv")

csvDF.registerTempTable("STOP_TABLE")

length_of_line_number = sqlContext.sql("SELECT STRING_LENGTH(VEHICLE_ID) FROM STOP_TABLE")
length_of_line_number.show(3)
```

pyspark SQL

SQL UDF & Schema Change

```
sparkcontext = SparkContext(conf= sparkconfig)
sqlContext = SQLContext(sparkcontext)

toIntegerfunc = UserDefinedFunction(lambda eachElement: int(eachElement),IntegerType())
toBooleanfunc = UserDefinedFunction(lambda eachElement : True if eachElement=='P'
                                    else False , BooleanType())

toDateFunc = UserDefinedFunction(lambda eachElement: datetime.strptime(eachElement,"%m/%d/%Y"),DateType())

csvDF = sqlContext.read \
    .option("header", "true") \
    .csv("/home/dharshekthvel/Downloads/stop.csv")

schema_modified_df = csvDF.withColumn("VEHICLE_ID", toIntegerfunc(csvDF["VEHICLE_ID"]))\
    .withColumn("PLAN_STATUS", toBooleanfunc(csvDF["PLAN_STATUS"]))\
    .withColumn("OPD_DATE", toDateFunc(csvDF["OPD_DATE"]))

#csvDF.printSchema()
#csvDF.show(2)

schema_modified_df.printSchema()
schema_modified_df.show(20)
```

```

from setuptools import setup, find_packages
# To use a consistent encoding
from codecs import open
from os import path

here = path.abspath(path.dirname(__file__))

setup(
    name='bdsparkler',
    version='3.0',
    description='Metrolinx Metadata',
    long_description="Metrolinx Project",
    url='http://metrolinx.com',
    author='Sri',
    author_email='sri@metrolinx.com',
    license='Copyright',
    classifiers=[
        'Development Status :: 1 - Alpha',
    ],
    # Indicate who your project is intended for
    'Intended Audience :: Developers',
    'Topic :: Software Development :: Build Tools',
    'Programming Language :: Python :: 2',
    'Programming Language :: Python :: 2.7',
    'Programming Language :: Python :: 3',
    'Programming Language :: Python :: 3.3',
    'Programming Language :: Python :: 3.4',
    'Programming Language :: Python :: 3.5',
],
    packages=find_packages(exclude=['contrib', 'docs', 'tests']),
    extras_require={
        'dev': ['check-manifest'],
        'test': ['coverage'],
    },
    package_data={
        'sample': ['package_data.dat'],
    },
    py_modules=["__main__"],
    entry_points={
        'console_scripts': [
            'sample=sample:main',
        ],
    },
)
# Copy the main file to the dist directory
from shutil import copyfile
copyfile("main.py", "dist/main.py")

```

egg

Spark-Submit

```
spark-submit --py-files=bdsparkler-3.0-py2.7.egg main.py
```

```
spark-submit --py-files=bdsparkler-3.0-py2.7.egg main.py --job=JobName --file=/home/dharshekthvel/Downloads/stop.csv
```

```
from spark_job import sql_schema_job
```

```
import sys, getopt
```

```
def help():
    help_statement = "HELP !!!"
    return help_statement
```

```
if __name__ == "__main__":
```

```
    file = "/home/dharshekthvel/ac/code/scalatrainingintellij/data/trip_1.csv"
    print "Spark JOB Started ..."
    sql_schema_job.main(file)
```

Apache Zeppelin



Apache Zeppelin

Zeppelin

Zeppelin is a visualization tool with various support for interpreters.

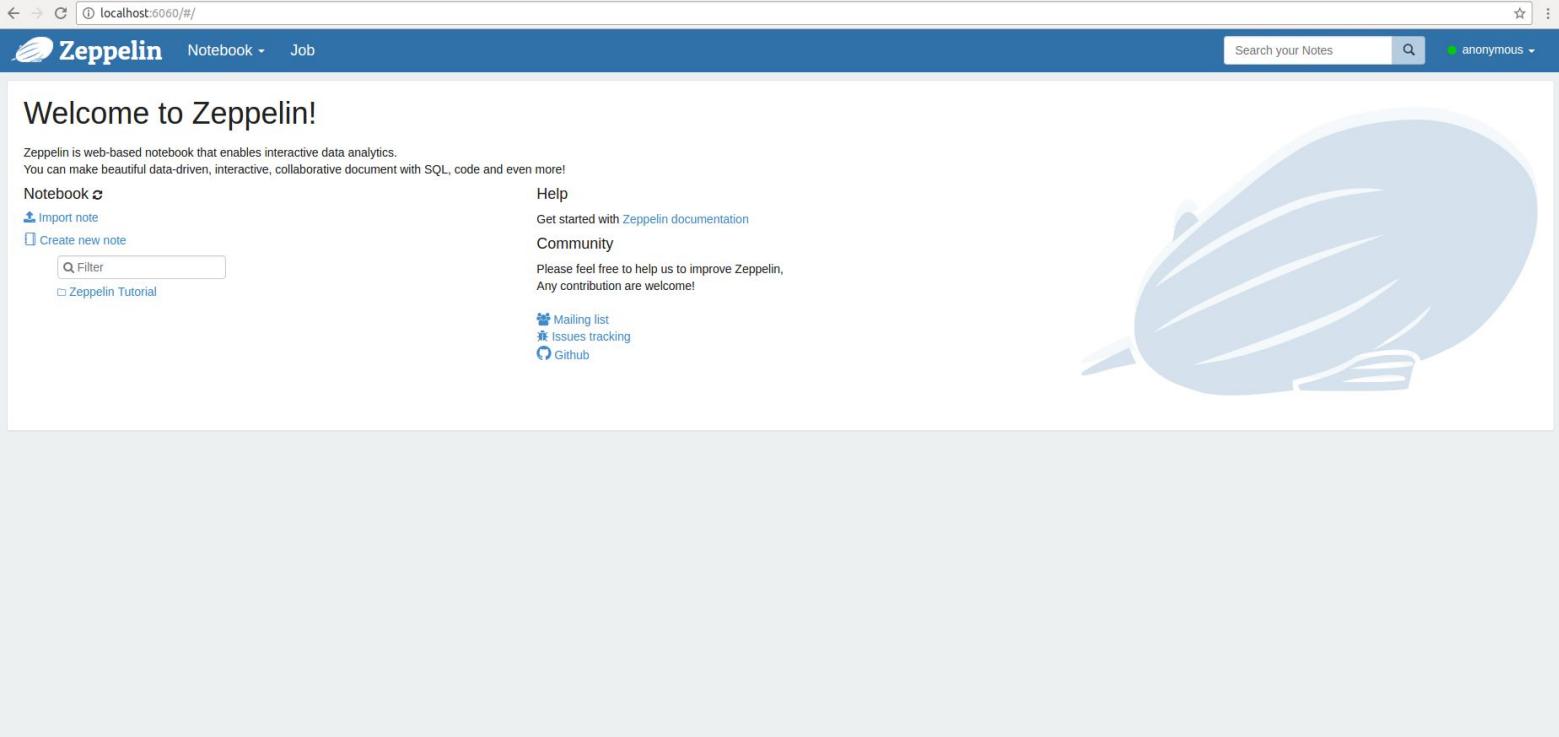
To start zeppelin:

[1] First configure the `conf/zeppelin-site.xml` in `conf` directory. There is a template file available. Rename it to `zeppelin-site.xml` and use the defaults.

[2] `dharshekthvel@dharshekthvel:~/ac/bin/zeppelin070/bin$./zeppelin.sh start`

[3] By default, zeppelin starts at port 8080.

Zeppelin UI



The screenshot shows the Zeppelin UI homepage at localhost:6060. The header includes the Zeppelin logo, navigation links for Notebook and Job, a search bar, and a user status indicator. The main content features a large, stylized graphic of a hot air balloon on the right. On the left, there's a "Welcome to Zeppelin!" message, a brief description of what Zeppelin is, and sections for Notebook operations (Import note, Create new note, Filter, Zeppelin Tutorial), Help (documentation link), and Community (links to Mailing list, Issues tracking, and Github).

Zeppelin

Apache Flink



Apache Flink

A set of robust API's for
Iterative algorithms, Streaming for Big Data

The underlying core engine is different from spark.

But the programming model is similar.

Apache Flink

A set of robust API's for
Iterative algorithms, Streaming for Big Data

The underlying core engine is different from spark.

But the programming model is similar.



Cassandra

Cassandra

First, start the server

\$ install_folder/bin/cassandra

\$ Then start the cqlsh

Start the cqlsh

```
Program Files\DataStax-DDC\apache-cassandra\bin>cqlsh
Connected to Test Cluster at 127.0.0.1:9042.
lsh 5.0.1 : Cassandra 3.3.0 | CQL spec 3.4.0 | Native protocol v4
: HELP for help.
: NING: pyreadline dependency missing. Install to enable tab completion.
sh> _
```

Cassandra

```
cqlsh help  
Documented shell commands:  
=====  
CAPTURE    CLS          COPY      DESCRIBE   EXPAND    LOGIN     SERIAL    SOURCE    UNICODE  
CLEAR      CONSISTENCY  DESC      EXIT       HELP      PAGING    SHOW      TRACING  
  
CQL help topics:  
=====  
AGGREGATES           CREATE_KEYSPACE        DROP_TRIGGER      TEXT  
ALTER_KEYSPACE        CREATE_MATERIALIZED_VIEW  DROP_TYPE        TIME  
ALTER_MATERIALIZED_VIEW CREATE_ROLE          DROP_USER        TIMESTAMP  
ALTER_TABLE           CREATE_TABLE          FUNCTIONS        TRUNCATE  
ALTER_TYPE            CREATE_TRIGGER        GRANT          TYPES  
ALTER_USER            CREATE_TYPE          INSERT          UPDATE  
APPLY                 CREATE_USER          INSERT_JSON      USE  
ASCII                DATE                  INT             UUID  
BATCH                DELETE                JSON  
BEGIN                DROP_AGGREGATE        KEYWORDS  
BLOB                 DROP_COLUMNFAMILY      LIST_PERMISSIONS  
BOOLEAN              DROP_FUNCTION         LIST_ROLES  
COUNTER              DROP_INDEX           LIST_USERS  
CREATE_AGGREGATE      DROP_KEYSPACE        PERMISSIONS  
CREATE_COLUMNFAMILY    DROP_MATERIALIZED_VIEW  REVOKE  
CREATE_FUNCTION       DROP_ROLE             SELECT  
CREATE_INDEX          DROP_TABLE            SELECT_JSON
```

cqlsh> _

Cassandra - Shell commands

Captures all the commands

```
cqlsh> CAPTURE 'out_capture.txt';
```

Gives in the detail about the cluster

```
cqlsh> describe cluster;
```

Lists all the keyspaces

```
cqlsh> describe keyspaces;
```

List all the tables

```
cqlsh> describe tables;
```

Cassandra - Shell Commands

Create table

```
cqlsh> create table <<keyspace>>. <<table>>(uid int PRIMARY KEY, otp text);  
cqlsh> create table uidai.otp(uid int PRIMARY KEY, otp text);
```

Insert Query

```
cqlsh> insert into uidai.otp (uid, otp) VALUES (12345536, '3456');
```

Select Query

```
cqlsh>select * from uidai.otp;
```

Cassandra - Core components

Commit Log, Memtable, SSTable, Bloom Filter are the basic core components of cassandra.

Commitlog: It is a crash recovery mechanism which maintains every write.

Memtable: After commit log, data is written in memtable. Memtable is a memory oriented entity.

Cassandra - Core components

SSTable: Data is flushed to the SSTable after the memtable has reached its fullest threshold.

Bloom filters: An algorithmic way to check whether the element is present or not.

Bloom filters are used check on the SSTable whether the data is present for a particular row or not.

Cassandra

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Apache Zookeeper

What is Zookeeper

A distributed system gives a single coherent view of many systems which are geographically distributed.

Zookeeper - a distributed,
Co-ordination service for distributed computing.

A Base manager. Taking care of synchronization, grouping, naming, configs, race conditions, deadlock, maintenance etc.,

So higher order services can be built on top of it.

Typically used in a place where there are many reads and few writes. An ideal candidate for Big-Data based applications.



What is Zookeeper

Zookeeper is a co-ordination, distributed service taking care of

- Status information

- Configuration

- Location Information

Zookeeper allows you to worry more on the application services built rather than on low level distributed framework.

Built by Yahoo for its in-house applications and later became opensource.

Zookeeper Architecture

1. Zookeeper data are stored internally and are called as *znode*.
2. Collection of Zookeeper servers are called *ensemble*.
3. Zookeeper can handle failures till its majority of the servers are up.
eg: On a 4 node cluster, a 1 node failure is tolerated. And on a 5 node cluster, 2 node failures are tolerated. Because on 5, 3 is a Majority.
4. Client write is sequential and also consistent.
5. Ephemeral Node: These nodes exist as long as the session exist. When the session ends, this ephemeral node is also removed.



Zookeeper Architecture

Zookeeper is a Apache open source which takes care of managing the cluster.

Structure of storage is simple as that of a unix tree structure, called by *shared hierarchical namespace*, which contains data registers called by name **znodes**.

Znodes are typically files and directories and can be accessed through zookeeper cli.

Zookeeper Architecture

Zookeeper data is kept in memory for high-throughput, high-performance and low latency.

Zookeeper data is replicated into the cluster of nodes called ensemble.

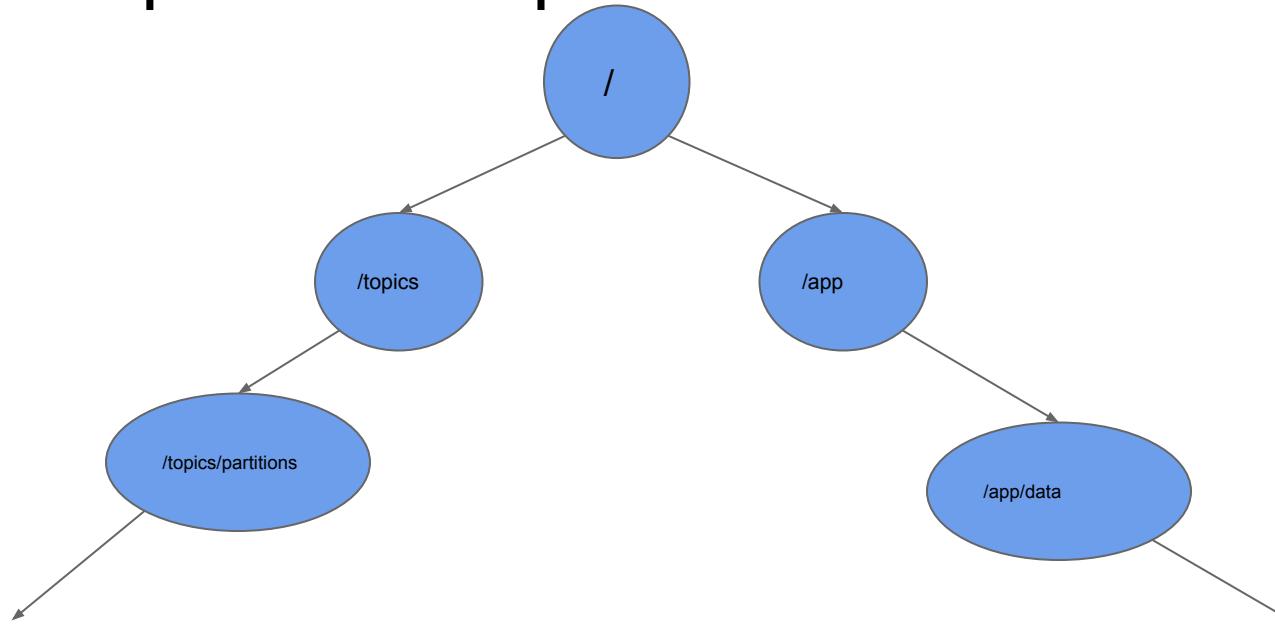
Zookeeper follows data ordering strictly.

Zookeeper holds data as filesystem. And data can have children.

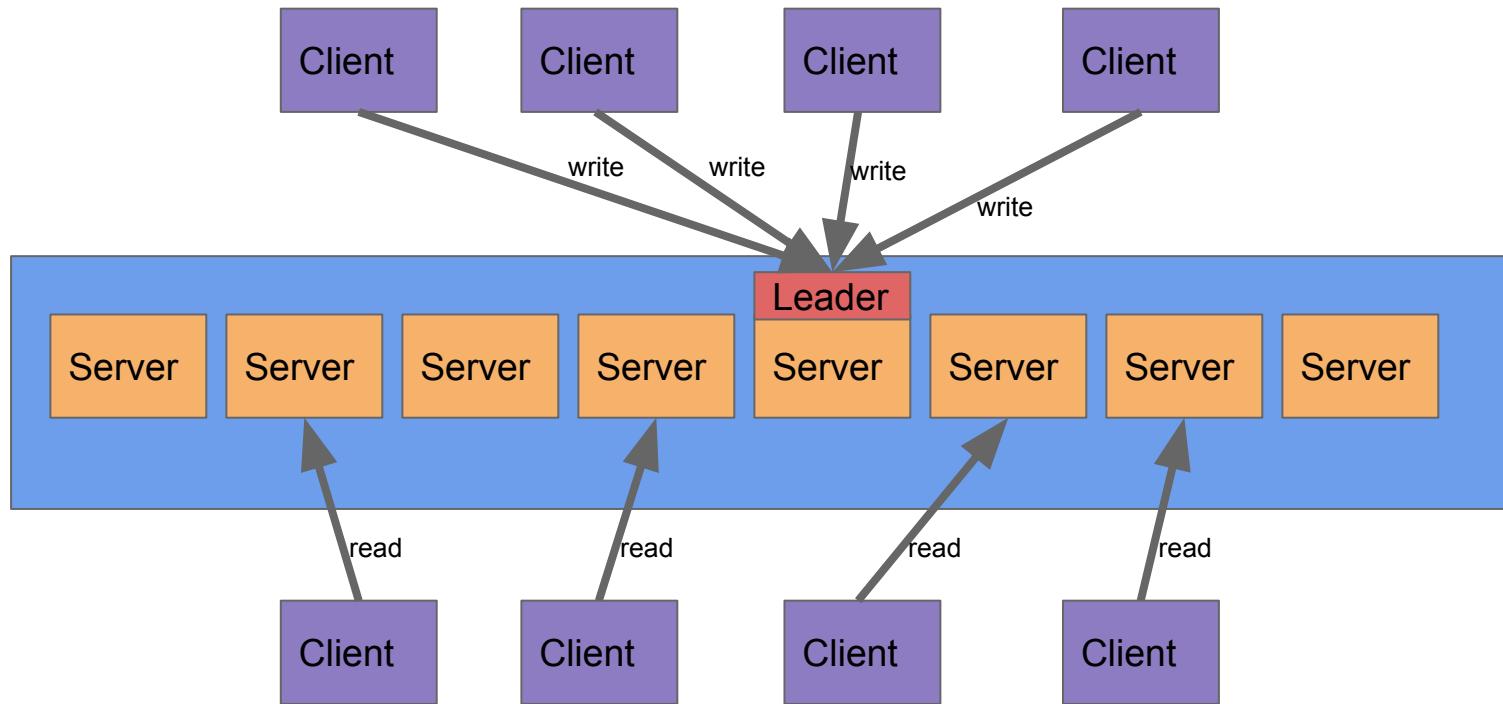
Zookeeper data transfer follows atomicity principle. i.e., Either all will succeed or will fail completely.

High reliable data across the nodes. This is guaranteed through znodes.

Zookeeper Namespace



Zookeeper Architecture



Zookeeper Architecture - Order of execution

- [1] When the client connects to the zookeeper server, a unique session id is generated and assigned to the client.
- [2] When the time-out of the client occurs or if there is no heartbeat received, then the client is considered dead and the ephemeral nodes created by the client is deleted.

[3] Read

A client directly requests the server in the zookeeper ensemble and the node directly retrieves the data from its own database. That's the reason, reads are faster in zookeeper.

[4] Write

In write process, the client sends the data and the znode path to the server,
The write request is sent to the leader,
the leader then sends the re-request to the followers for the write.
If only a majority of the servers ($\frac{4}{6}$) write, then there is success response sent back to the client. Otherwise the write will fail.
This majority of voting for write is called ***quorum***.

Zookeeper Architecture - Order of execution

Write

Write process is handled by the leader node. The leader forwards the write request to all the znodes and waits for answers from the znodes. If half of the znodes reply, then the write process is complete.

Read Reads are performed internally by a specific connected znode, so there is no need to interact with the cluster.

Leader The znode that is responsible for processing write requests.

Follower The followers receive write requests from the clients and forward them to the leader znode.

Zookeeper Architecture - Znode types

Persistent Znode : This znode type is persistent and is the default type.

Ephemeral Znode : This type of znode gets deleted when the session of the client expires.

Sequential Znode : Can either be persistent or ephemeral. Adds a increasing unique counter at the end of the node.

CreateMode.java

```
CreateMode {  
    PERSISTENT(0, false, false),  
    PERSISTENT_SEQUENTIAL(2, false, true),  
    EPHEMERAL(1, true, false),  
    EPHEMERAL_SEQUENTIAL(3, true, true);  
}
```

Zookeeper CLI

Zookeeper provides a Call-Level-Interface (a command-line client) which interacts with the zookeeper.

To connect to the zookeeper use the below command.

```
$ ./zookeeper-shell.sh localhost:2181
```

Zookeeper CLI

Create a znode and insert data into it.

```
$ create /bus_intro_csv "Data ingested into crocodile"
```

To view all the znodes.

```
$ ls /
```

Get the data about a znode.

```
$ get /bus_intro_csv
```

To modify the data

```
$ set /bus_intro_csv "Modified Data"
```

Delete a znode.

```
$ delete /bus_intro_csv
```

To exit

```
$ quit
```

Zookeeper CLI

Close the connection

```
$ close
```

To connect

```
$ connect localhost:2181
```

Zookeeper CLI

Kafka Topic

The details about the kafka topic is stored in the following place:

```
$ ls /brokers/topics/BULK_LOAD/partitions/0/state
```

Zookeeper Java Code - Create Znode

```
ZooKeeper zookeeper = new ZooKeeper("localhost", 5000, new Watcher() {  
    @Override  
    public void process(WatchedEvent watchedEvent) {  
        }  
    });  
  
byte[] data = "My first zookeeper app".getBytes();  
  
zookeeper.create("/ARAVINDH-TOPIC", data, ZooDefs.Ids.OPEN_ACL_UNSAFE, CreateMode.PERSISTENT);
```

Zookeeper Projects

The following are the projects that are built on top of zookeeper.

KAFKA

HBASE

SOLR

YAHOO



Apache Kafka

A high-throughput distributed messaging system.

Why do we need high-throughput messaging

- [#] Too many events coming on a short interval of time. Put in a queue and process it later.
- [#] Era of data, so we need a high-throughput messaging system rather than a conventional messaging.

Apache Kafka

Kafka is a high throughput,

partitioned,

messaging system from LinkedIn.

An unified platform for handling all real-time data that LinkedIn has.



Apache Kafka

Kafka is a persistent distributed log.

Distributed log meaning *spread across the cluster*.

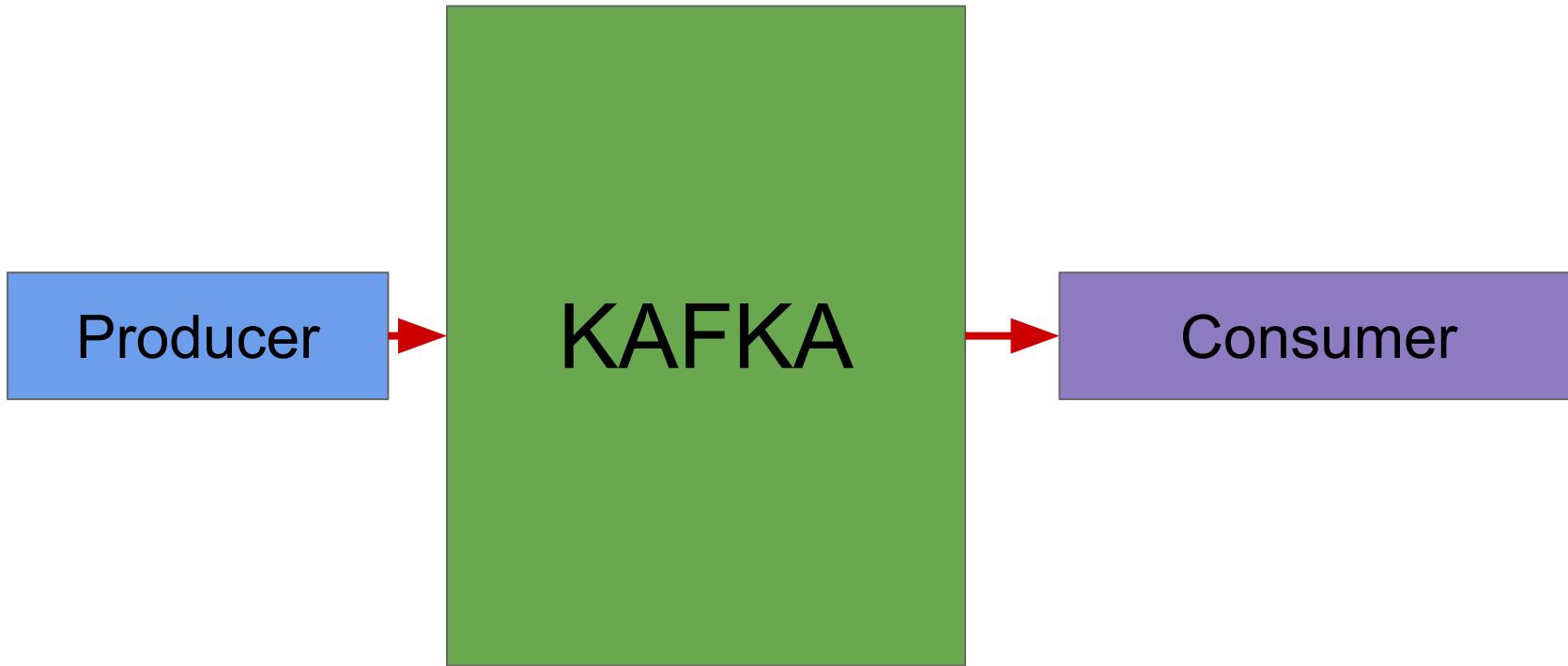
Log in the sense, *has a append only sequence of messages, bounded length,*
allows random reads.

Apache Kafka

Mostly written in Java.

Also contains scala code.

Kafka - Producer and Consumer



Kafka advantages over other Queueing systems

- [1] Sequential disk access, which results in optimal disk utilization.
- [2] Zero copy, which saves CPU cycles.
- [3] Compression, which saves network bandwidth.
- [4] Growing community and traction in Big Data.

The zero copy approach

Zero copy is a mechanism by which the kernel space writes the data to the socket without any user-space, thereby reducing CPU cycles and context switching, which increases fast data transfer.

Kafka Installation

<https://kafka.apache.org/downloads>



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Download

0.10.2.1 is the latest release. The current stable version is 0.10.2.1.

You can verify your download by following these [procedures](#) and using these [KEYS](#).

0.10.2.1

- [Release Notes](#)
- Source download: [kafka-0.10.2.1-src.tgz](#) (asc, md5)
- Binary downloads:
 - Scala 2.10 - [kafka_2.10-0.10.2.1.tgz](#) (asc, md5)
 - Scala 2.11 - [kafka_2.11-0.10.2.1.tgz](#) (asc, md5)
 - Scala 2.12 - [kafka_2.12-0.10.2.1.tgz](#) (asc, md5)

We add 2.12 to the supported Scala version. These different versions only matter if you are using Scala and you want a version built for the same Scala version you use. Otherwise any version should work (2.12 is recommended).

0.10.2.0

- [Release Notes](#)
- Source download: [kafka-0.10.2.0-src.tgz](#) (asc, md5)
- Binary downloads:
 - Scala 2.10 - [kafka_2.10-0.10.2.0.tgz](#) (asc, md5)

Goto

https://www.apache.org/dyn/closer.cgi?path=/kafka/0.10.2.1/kafka_2.10-0.10.2.1.tgz

china_email@163.com



Kafka Installation

In order to start kafka, first start zookeeper and then start kafka

To start zookeeper, use the below command

./zookeeper-server-start.sh ..//config/zookeeper.properties

After starting zookeeper, then start kafka with the below command

./kafka-server-start.sh ..//config/server.properties

Kafka Installation

./zookeeper-server-start.sh ..//config/zookeeper.properties



Zookeeper starts on port 2181 by default

```
[2017-06-04 13:56:15,030] INFO Server environment:java.library.path=/usr/java/packages/lib/amd64:/usr/lib64:/lib64:/lib:/usr/lib (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:java.io.tmpdir=/tmp (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:java.compiler=<NA> (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:os.name=Linux (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:os.arch=amd64 (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:os.version=4.4.0-31-generic (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:user.name=dharshekthvel (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:user.home=/home/dharshekthvel (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,030] INFO Server environment:user.dir=/home/dharshekthvel/ac/bin/kafka2110102/bin (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,039] INFO tickTime set to 3000 (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,039] INFO minSessionTimeout set to -1 (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,039] INFO maxSessionTimeout set to -1 (org.apache.zookeeper.server.ZooKeeperServer)
[2017-06-04 13:56:15,055] INFO binding to port 0.0.0.0/0.0.0.0:2181 (org.apache.zookeeper.server.NIOServerCnxnFactory)
[2017-06-04 13:56:25,275] INFO Accepted socket connection from /127.0.0.1:54872 (org.apache.zookeeper.server.NIOServerCnxnFactory)
[2017-06-04 13:56:25,281] INFO Processing ruok command from /127.0.0.1:54872 (org.apache.zookeeper.server.NIOServerCnxn)
[2017-06-04 13:56:25,283] INFO Closed socket connection for client /127.0.0.1:54872 (no session established for client) (org.apache.zookeeper.server.NIOServerCnxn)
```

Kafka Installation

./kafka-server-start.sh ..//config/server.properties

```
[2017-06-04 14:00:29,160] INFO Client environment:user.name=dharshekthvel (org.apache.zookeeper.ZooKeeper)
[2017-06-04 14:00:29,160] INFO Client environment:user.home=/home/dharshekthvel (org.apache.zookeeper.ZooKeeper)
[2017-06-04 14:00:29,160] INFO Client environment:user.dir=/home/dharshekthvel/ac/bin/kafka2110102/bin (org.apache.zookeeper.ZooKeeper)
[2017-06-04 14:00:29,161] INFO Initiating client connection, connectString=localhost:2181 sessionTimeout=6000 watcher=org.I0Itec.zkclient.ZkClient@333291e3 (org.apache.zookeeper.ClientCnxn)
[2017-06-04 14:00:29,172] INFO Waiting for keeper state SyncConnected (org.I0Itec.zkclient.ZkClient)
[2017-06-04 14:00:29,173] INFO Opening socket connection to server localhost/127.0.0.1:2181. Will not attempt to authenticate using SASL (unknown error) (org.apache.zookeeper.ClientCnxn)
[2017-06-04 14:00:29,178] INFO Socket connection established to localhost/127.0.0.1:2181, initiating session (org.apache.zookeeper.ClientCnxn)
[2017-06-04 14:00:29,193] INFO Session establishment complete on server localhost/127.0.0.1:2181, sessionid = 0x15c7236389d0000, negotiated timeout = 6000 (org.apache.zookeeper.ClientCnxn)
[2017-06-04 14:00:29,195] INFO zookeeper state changed (SyncConnected) (org.I0Itec.zkclient.ZkClient)
[2017-06-04 14:00:29,318] INFO Cluster ID = z6a_aOAsSTqek6hewZz1tQ (kafka.server.KafkaServer)
[2017-06-04 14:00:29,322] WARN No meta.properties file under dir /tmp/kafka-logs/meta.properties (kafka.server.BrokerMetadataCheckpoint)
[2017-06-04 14:00:29,338] INFO [ThrottledRequestReaper-Fetch], Starting (kafka.server.ClientQuotaManager$ThrottledRequestReaper)
[2017-06-04 14:00:29,340] INFO [ThrottledRequestReaper-Producer], Starting (kafka.server.ClientQuotaManager$ThrottledRequestReaper)
[2017-06-04 14:00:29,365] INFO Log directory '/tmp/kafka-logs' not found, creating it. (kafka.log.LogManager)
[2017-06-04 14:00:29,376] INFO Loading logs. (kafka.log.LogManager)
[2017-06-04 14:00:29,389] INFO Logs loading complete in 13 ms. (kafka.log.LogManager)
[2017-06-04 14:00:29,416] INFO Starting log cleanup with a period of 300000 ms. (kafka.log.LogManager)
[2017-06-04 14:00:29,417] INFO Starting log flusher with a default period of 9223372036854775807 ms. (kafka.log.LogManager)
[2017-06-04 14:00:29,449] INFO Awaiting socket connections on 0.0.0.0:9092. (kafka.network.Acceptor)
[2017-06-04 14:00:29,451] INFO [Socket Server on Broker 0], Started 1 acceptor threads (kafka.network.SocketServer)
[2017-06-04 14:00:29,468] INFO [ExpirationReaper-0], Starting (kafka.server.DelayedOperationPurgatory$ExpiredOperationReaper)
[2017-06-04 14:00:29,469] INFO [ExpirationReaper-0], Starting (kafka.server.DelayedOperationPurgatory$ExpiredOperationReaper)
[2017-06-04 14:00:29,497] INFO Creating /controller (is it secure? false) (kafka.utils.ZKCheckedEphemeral)
[2017-06-04 14:00:29,502] INFO Result of znode creation is: OK (kafka.utils.ZKCheckedEphemeral)
[2017-06-04 14:00:29,502] INFO 0 successfully elected as leader (kafka.server.ZookeeperLeaderElector)
[2017-06-04 14:00:29,570] INFO [ExpirationReaper-0], Starting (kafka.server.DelayedOperationPurgatory$ExpiredOperationReaper)
[2017-06-04 14:00:29,574] INFO [ExpirationReaper-0], Starting (kafka.server.DelayedOperationPurgatory$ExpiredOperationReaper)
[2017-06-04 14:00:29,575] INFO [ExpirationReaper-0], Starting (kafka.server.DelayedOperationPurgatory$ExpiredOperationReaper)
[2017-06-04 14:00:29,588] INFO [GroupCoordinator 0]: Starting up. (kafka.coordinator.GroupCoordinator)
[2017-06-04 14:00:29,589] INFO [GroupCoordinator 0]: Startup complete. (kafka.coordinator.GroupCoordinator)
[2017-06-04 14:00:29,590] INFO [Group Metadata Manager on Broker 0]: Removed 0 expired offsets in 1 milliseconds. (kafka.coordinator.GroupMetadataManager)
[2017-06-04 14:00:29,608] INFO Will not load MX4J, mx4j-tools.jar is not in the classpath (kafka.utils.Mx4jLoader$)
[2017-06-04 14:00:29,624] INFO New leader is 0 (kafka.server.ZookeeperLeaderElector$LeaderChangeListener)
[2017-06-04 14:00:29,634] INFO Creating /brokers/ids/0 (is it secure? false) (kafka.utils.ZKCheckedEphemeral)
[2017-06-04 14:00:29,638] INFO Result of znode creation is: OK (kafka.utils.ZKCheckedEphemeral)
[2017-06-04 14:00:29,639] INFO Registered broker 0 at path /brokers/ids/0 with addresses:EndPoint(dharshekthvel,9092,ListenerName(PLAINTEXT),PLAINTEXT) (kafka.utils.ZkUtils)
[2017-06-04 14:00:29,640] WARN No meta.properties file under dir /tmp/kafka-logs/meta.properties (kafka.server.BrokerMetadataCheckpoint)
[2017-06-04 14:00:29,657] INFO Kafka version : 0.10.2.0 (org.apache.kafka.common.utils.AppInfoParser)
[2017-06-04 14:00:29,657] INFO Kafka commitId: 576d93a8dc0cf421 (org.apache.kafka.common.utils.AppInfoParser)
[2017-06-04 14:00:29,658] INFO [Kafka Server 0], started (kafka.server.KafkaServer)
```

Kafka starts on port 9092 by default

Role of Zookeeper in Kafka

[1] Election of Controller

The controller is a broker which takes the responsibility of electing the leader and follower for each of the partition.

[2] Cluster management

Which part of the node (broker) is alive.

[3] ACL for each topics.

[4] What are the topics. How many partitions each topic has. The state of each partition.

Zookeeper role in kafka

Partition states

Broker registration

Zookeeper knows what all the nodes of kafka are forming the kafka cluster.

Consumer registration and subscription

Messaging guarantees

Messages sent by a producer to a topic are stored in the log by order.

The consumer also sees (consumes) the record, in the same order by which the records are written.

Kafka tolerates up to $N-1$ broker failures which has N replication.

What's next

- [*] Producer and Consumer using console.
- [*] Producer and Consumer through Programmatic Approach
- [*] How to tune in parameters for maximum throughput

Producer and Consumer - Using console

Create a topic:

```
$ ./kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic Lohith_Topic
```

Console Producer:

```
./kafka-console-producer.sh --broker-list localhost:9092 --topic Lohith_Topic
```

The console producer with key and value:

```
./kafka-console-producer.sh --broker-list localhost:9092 --topic Squad-Topic --property parse.key=true  
--property key.separator=:
```

Console Consumer:

```
./kafka-console-consumer.sh --zookeeper localhost:9092 --topic Lohith_Topic --from-beginning
```

(or)

```
./kafka-console-consumer.sh --bootstrap-server localhost:9092 --topic Lohith_Topic --from-beginning
```

Terminologies

Brokers

Producer

Consumer

Consumer Groups and Consumers

Topic

Partition

Segments

Offset

Terminologies

- | | |
|-----------|---|
| Brokers | - Individual nodes in kafka are called brokers. |
| Producer | - Producers write data to brokers. |
| Consumer | - Consumers read data from brokers. |
| Topic | - Data is stored in topics. |
| Partition | - Topics are split into partitions, which are distributed and replicated. |
| Offset | - Pointer by which Producer and Consumer keep track of data. |

Producer, Consumer, Topics, Partition

Producer writes data to brokers.

Consumer reads data from brokers.

Data is stored in **topics**.

Topics are split into **partitions**, which are **replicated**.

Topics consists of partitions. A partition contains **ordered** and **immutable** sequence of messages.

Producer

Producer publish data to *topic*.

Topic is made of *partitions*.

Producer is responsible for assigning data to a particular partition.

You can create any number of partitions to a topic.

By default kafka assigns data to partition based on round robin.

You can also write a custom partitioner for storing data to partition.

Scala Producer

[1] Create the KafkaProducer.

[2] Create the ProducerRecord

```
val data = new ProducerRecord[String, String]("TOPIC_NAME", "key", "value")
```

[3] Using producer, send() the data

[4] producer flush()

Kafka ensures that all previously sent messages has been completed. This is done using flush().

[5] Close the producer

Scala Producer - Asynchronous

```
val props = new Properties()
props.put("bootstrap.servers", "localhost:9092")
props.put("client.id", "SLZ_CHAMBER")
props.put("key.serializer", "org.apache.kafka.common.serialization.StringSerializer")
props.put("value.serializer", "org.apache.kafka.common.serialization.StringSerializer")
props.put("linger.ms", "1")
props.put("batch.size", "445")
props.put("compression.codec", "1")
```

```
val producer = new KafkaProducer[String, String](props)

val data = new ProducerRecord[String, String]("SLZCHAMBER", "key_1", "MAY-17-Revolution-1")

// Just a call to send will be non-blocking
producer.send(data)

producer.close()
```

Scala Producer - Asynchronous - Blocking

```
val producer = new KafkaProducer[String, String](props)  
val data = new ProducerRecord[String, String]("SLZCHAMBER", "key_1", "MAY-17-Revolution-1")
```

```
// Calling send() with get will be a blocking.  
val metadata = producer.send(data).get()
```

```
println(metadata.offset())  
println(metadata.partition())  
println(metadata.topic())  
println(metadata.serializedKeySize())  
println(metadata.serializedValueSize())
```

```
producer.close()
```

Scala Producer - Send data to particular partition

You can specify the partition to send in data. Here the data is sent to the partition 0.

```
val producer = new KafkaProducer[String, String](props)  
  
// Send data to a particular partition  
val data = new ProducerRecord[String, String]("BINTELLIGENCE", 0, "key_12", "Richard Feynman 101 - thank you for your physics")  
  
producer.send(data)
```

Scala Producer - Producer Record

Ways to create ProducerRecord. With variants of Key, Value, Topic, Partitions and Timestamp.

```
val data1 = new ProducerRecord[String, String]("TOPIC", "KEY", "VALUE")
val data2 = new ProducerRecord[String, String]("TOPIC", 100, "KEY", "VALUE")
val data3 = new ProducerRecord[String, String]("TOPIC", "VALUE")
val data4 = new ProducerRecord[String, String]("TOPIC", 100, today.getTime, "KEY", "VALUE")
```

```
val today = new java.util.Date();
today.getTime;
```

Scala Producer - With callback

```
val producer = new KafkaProducer[String, String](props)  
  
// Send data to a particular partition  
val data = new ProducerRecord[String, String]("BINTELLIGENCE", 0, "key_12", "Richard Feynman 101 - thank you for your physics")  
  
producer.send(data, oncallback)
```

Note: Callbacks sent to the same partition are guaranteed to execute in the same order

```
val oncallback = new Callback {  
    override def onCompletion(recordMetadata:  
        RecordMetadata, e: Exception) = {  
        println(recordMetadata.offset())  
        println(recordMetadata.checksum())  
        println(recordMetadata.topic())  
        println(recordMetadata.partition())  
    }  
}
```

Scala Producer

client.id Logical application name
The Application name of the producer.

```
props.put("key.serializer", "org.apache.kafka.common.serialization.StringSerializer");  
props.put("value.serializer", "org.apache.kafka.common.serialization.StringSerializer");  
Serializer has to be given at the time of producing.  
Deserializer has to be given at the time of consuming.
```

Kafka Producer

Kafka producer writes data to Commit Log

Producers always appends to the file of commit log.

Producer - Custom Partitioner

```
class KafkaUserCustomPartitioner extends Partitioner {  
  
    override def close(): Unit = {}  
  
    override def configure(map: util.Map[String, _]): Unit = {}  
  
    override def partition(topic: String, key: scala.Any, keybytes: Array[Byte], value: scala.Any,  
                          valuebytes: Array[Byte], cluster: Cluster): Int =  
    {  
  
        val key_ = key.asInstanceOf[String]  
        if (key_.startsWith("M"))  
            1  
        else if (key_.startsWith("C"))  
            6  
        else  
            9  
    }  
}  
KafkaUserCustomPartitioner.scala
```

In your properties use the custom partitioner class.

```
props.put("partitioner.class",  
         "com.dmac.kafka.KafkaUserCustomPartitioner");
```

Producer - Custom Partitioner

```
val props = new Properties()
props.put("bootstrap.servers", "localhost:9092")
props.put("client.id", "Mesh_Group")
props.put("key.serializer", "org.apache.kafka.common.serialization.StringSerializer")
props.put("value.serializer", "org.apache.kafka.common.serialization.StringSerializer")
props.put("linger.ms", "1")
props.put("batch.size", "1")
props.put("compression.codec", "1")
props.put("partitioner.class", "com.dmac.kafka.KafkaUserCustomPartitioner");
```

```
val producer = new KafkaProducer[String, String](props)
```

```
for (i <- 1 to 100) {
    val key = "Mesh_key".concat(i.toString)
    val value = "MESH_VALUE_".concat(i.toString)

    val data = new ProducerRecord[String, String]("MESH_TOPIC",
                                                key,
                                                value)

    producer.send(data)
}

producer.close()
```

UsingCustomKafkaPartitioner.scala

Producer - Custom Partitioner

Run the below command, to check if the data is actually stored in that partition.

```
./kafka-run-class.sh kafka.tools.DumpLogSegments --deep-iteration --print-data-log --files  
/tmp/dharshekth-kafka/MESH_TOPIC-1/000000000000000000000000.log
```

```
dharshekthvel@dharshekthvel:~/ac/bin/kafka21101100/bin$ ./kafka-run-class.sh kafka.tools.DumpLogSegments --deep-iteration --print-data-log --files  
/tmp/kafka-logs/VEH-TOPIC-2/000000000000000000000000.log  
Dumping /tmp/kafka-logs/VEH-TOPIC-2/000000000000000000000000.log
```

```
Starting offset: 0  
offset: 0 position: 0 CreateTime: 1503634047611 isValid: true keysize: 6 valuesize: 27 magic: 2 compresscodec: NONE producerId: -1 sequence: -1 isTransactional: false headerKeys: [] key: key_12 payload: data ingested to partition 2  
  
offset: 1 position: 101 CreateTime: 1503634104503 isValid: true keysize: 6 valuesize: 27 magic: 2 compresscodec: NONE producerId: -1 sequence: -1 isTransactional: false headerKeys: [] key: key_12 payload: data ingested to partition 2
```

payload will contain the actual message

Kafka Producer - Metrics

```
KafkaProducer producer = new KafkaProducer<String, String>(props);

ProducerRecord data = new ProducerRecord<String, String>("BHAS-TOPIC", "seektoend", "time-line-at-84765672464");

producer.send(data);

Map<MetricName, Metric> metrics = producer.metrics();
metrics.forEach(new IteratorMetricClass());
```

```
class IteratorMetricClass implements BiConsumer<MetricName, Metric> {
    @Override
    public void accept(MetricName metricName, Metric metric) {
        System.out.println(metric.metricName().description() + " - " + metric.value() + " - " + metricName.name());
    }
}
```

Kafka Producer - Metrics

The average number of records sent per second. - 0.0 - record-send-rate

The average time in ms record batches spent in the record accumulator. - 0.0 - record-queue-time-avg

The average length of time the I/O thread spent waiting for a socket ready for reads or writes in nanoseconds. - 2038974.625 - io-wait-time-ns-avg

The rate of record batch split - 0.0 - batch-split-rate

The average number of outgoing bytes sent per second to all servers. - 1.630561378989052 - outgoing-byte-rate

The average number of network operations (reads or writes) on all connections per second. - 0.13310705134604506 - network-io-rate

New connections established per second in the window. - 0.03324578609661225 - connection-creation-rate

Connections closed per second in the window. - 0.0 - connection-close-rate

The maximum size of any request sent in the window. - 31.0 - request-size-max

- 10.915141430948418 - incoming-byte-rate

Responses received sent per second. - 0.06655574043261231 - response-rate

The maximum size of any request sent in the window. - -Infinity - request-size-max

The average size of all requests in the window.. - 24.5 - request-size-avg

The average length of time for I/O per select call in nanoseconds. - 444352.71428571426 - io-time-ns-avg

- 0.0 - outgoing-byte-rate

total number of registered metrics - 55.0 - count

- 0.0 - request-latency-avg

The average size of all requests in the window.. - 0.0 - request-size-avg

The current number of active connections. - 2.0 - connection-count

The average number of records per request. - 0.0 - records-per-request-avg

The number of user threads blocked waiting for buffer memory to enqueue their records - 0.0 - waiting-threads

The average per-second number of record sends that are dropped due to buffer exhaustion - 0.0 - buffer-exhausted-rate

The average number of responses received per second. - 0.06655574043261231 - response-rate

The maximum size of any request sent in the window. - 31.0 - request-size-max

The average per-second number of retried record sends - 0.0 - record-retry-rate

The maximum record size - -Infinity - record-size-max

The average number of requests sent per second. - 0.0333333333333333 - request-rate

Number of times the I/O layer checked for new I/O to perform per second - 0.29876510423582525 - select-rate

The total amount of buffer memory that is not being used (either unallocated or in the free list). - 3.3553987E7 - buffer-available-bytes

The maximum time in ms record batches spent in the record accumulator. - -Infinity - record-queue-time-max

.....

.....

Producer - Topics - Partition

RECAP

Producer writes data to brokers.

Data is stored in **topics**.

Topics are split into **partitions**, which are **replicated**.

Topic

Create a topic:

```
$ ./kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 2 --partitions 10 --topic Lohith_Topic
```

Replication factor can either be equal or less than the number of brokers.

My broker was only one, but if I give in the replication factor as 2, I get the below message.

Error while executing topic command : replication factor: 2 larger than available brokers: 1

```
[2017-06-20 11:38:39,607] ERROR org.apache.kafka.common.errors.InvalidReplicationFactorException: replication factor: 2 larger than available brokers: 1  
(kafka.admin.TopicCommand$)
```

Topic operations

Listing the topic

```
$ ./kafka-topics.sh --list --zookeeper localhost:2181
```

Deleting a topic

```
$ ./kafka-topics.sh --zookeeper localhost:2181 --delete --topic CHOLA
```

But this will have impact only when **delete.topic.enable** is set to true

Topic - auto.create = false

In the server.properties if you make auto.create.topics.enable to false. Then you need to create a topic manually.

auto.create.topics.enable=false

By default the auto.create.topics.enable is true.

Topic <-> Partition

Partition

Topic partition is the key-unit of parallelism in kafka.

Topic partition not only supports on scaling but also in storage and operations.

Partitions

```
./kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 1 --partitions 100 --topic CHEGUERA
```

100 Partitions are created for the topic CHEGUERA.

100 directory logs are created for CHEGUERA topic.

It's created in /tmp/dharshekth-kafka directory.

Default is /tmp/kafka-logs.

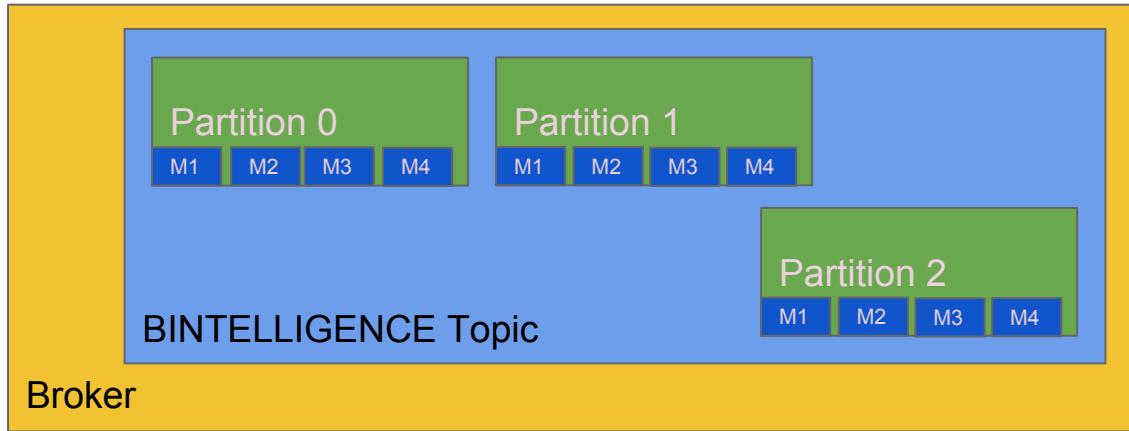
To change the location, goto config/server.properties

and change the **log.dirs** value.

log.dirs=/tmp/dharshekth-kafka

```
CHEGUERA-33/ CHEGUERA-70/ CHOLA-17/ CHOLA-54/ CHOLA-91/  
CHEGUERA-34/ CHEGUERA-71/ CHOLA-18/ CHOLA-55/ CHOLA-92/  
CHEGUERA-35/ CHEGUERA-72/ CHOLA-19/ CHOLA-56/ CHOLA-93/  
CHEGUERA-36/ CHEGUERA-73/ CHOLA-20/ CHOLA-57/ CHOLA-94/  
CHEGUERA-37/ CHEGUERA-74/ CHOLA-20/ CHOLA-58/ CHOLA-95/  
CHEGUERA-38/ CHEGUERA-75/ CHOLA-21/ CHOLA-59/ CHOLA-96/  
CHEGUERA-39/ CHEGUERA-76/ CHOLA-22/ CHOLA-60/ CHOLA-97/  
CHEGUERA-4/ CHEGUERA-77/ CHOLA-23/ CHOLA-61/ CHOLA-98/  
CHEGUERA-40/ CHEGUERA-78/ CHOLA-24/ CHOLA-62/ CHOLA-99/  
CHEGUERA-41/ CHEGUERA-79/ CHOLA-25/ CHOLA-63/ cleaner-offset-checkpoint  
CHEGUERA-42/ CHEGUERA-80/ CHOLA-26/ CHOLA-64/ lock  
CHEGUERA-43/ CHEGUERA-81/ CHOLA-27/ CHOLA-65/ meta.properties  
CHEGUERA-44/ CHEGUERA-82/ CHOLA-28/ CHOLA-66/ recovery-point-offset-checkpoint  
CHEGUERA-45/ dhrshekthvel@dharshekthvel:~/ac/bin/kafka2110102/bin$ clear replication-offset-checkpoint  
dhrshekthvel@dharshekthvel:~/ac/bin/kafka2110102/bin$ ls /tmp/dharshekth-kafka/  
CHEGUERA-0 CHEGUERA-22 CHEGUERA-36 CHEGUERA-5 CHEGUERA-63 CHEGUERA-77 CHEGUERA-90 CHOLA-13 CHOLA-27 CHOLA-40 CHOLA-54 CHOLA-68 CHOLA-81 CHOLA-95  
CHEGUERA-1 CHEGUERA-23 CHEGUERA-37 CHEGUERA-50 CHEGUERA-64 CHEGUERA-78 CHEGUERA-91 CHOLA-14 CHOLA-28 CHOLA-41 CHOLA-55 CHOLA-69 CHOLA-82 CHOLA-96  
CHEGUERA-2 CHEGUERA-24 CHEGUERA-38 CHEGUERA-51 CHEGUERA-65 CHEGUERA-79 CHEGUERA-92 CHOLA-15 CHOLA-29 CHOLA-42 CHOLA-56 CHOLA-70 CHOLA-83 CHOLA-97  
CHEGUERA-3 CHEGUERA-25 CHEGUERA-39 CHEGUERA-52 CHEGUERA-66 CHEGUERA-80 CHEGUERA-93 CHOLA-16 CHOLA-3 CHOLA-43 CHOLA-57 CHOLA-78 CHOLA-84 CHOLA-98  
CHEGUERA-4 CHEGUERA-26 CHEGUERA-40 CHEGUERA-53 CHEGUERA-67 CHEGUERA-80 CHEGUERA-94 CHOLA-17 CHOLA-30 CHOLA-44 CHOLA-58 CHOLA-71 CHOLA-85 CHOLA-99  
CHEGUERA-5 CHEGUERA-27 CHEGUERA-41 CHEGUERA-54 CHEGUERA-68 CHEGUERA-81 CHEGUERA-95 CHOLA-18 CHOLA-31 CHOLA-45 CHOLA-59 CHOLA-72 CHOLA-86 cleaner-offset-checkpoint  
CHEGUERA-6 CHEGUERA-28 CHEGUERA-42 CHEGUERA-55 CHEGUERA-69 CHEGUERA-82 CHEGUERA-96 CHOLA-19 CHOLA-32 CHOLA-46 CHOLA-60 CHOLA-73 CHOLA-87 meta.properties  
CHEGUERA-7 CHEGUERA-29 CHEGUERA-43 CHEGUERA-56 CHEGUERA-70 CHEGUERA-83 CHEGUERA-97 CHOLA-20 CHOLA-33 CHOLA-47 CHOLA-61 CHOLA-74 CHOLA-88 recovery-point-offset-checkpoint  
CHEGUERA-8 CHEGUERA-30 CHEGUERA-44 CHEGUERA-57 CHEGUERA-71 CHEGUERA-84 CHEGUERA-98 CHOLA-21 CHOLA-34 CHOLA-48 CHOLA-61 CHOLA-75 CHOLA-89 replication-offset-checkpoint  
CHEGUERA-9 CHEGUERA-31 CHEGUERA-45 CHEGUERA-59 CHEGUERA-72 CHEGUERA-85 CHEGUERA-99 CHOLA-22 CHOLA-36 CHOLA-5 CHOLA-63 CHOLA-77 CHOLA-90  
CHEGUERA-10 CHEGUERA-32 CHEGUERA-46 CHEGUERA-60 CHEGUERA-73 CHEGUERA-86 CHOLA-23 CHOLA-37 CHOLA-59 CHOLA-64 CHOLA-78 CHOLA-91  
CHEGUERA-11 CHEGUERA-33 CHEGUERA-47 CHEGUERA-61 CHEGUERA-74 CHEGUERA-87 CHEGUERA-90 CHOLA-24 CHOLA-38 CHOLA-60 CHOLA-79 CHOLA-82 CHOLA-93  
CHEGUERA-12 CHEGUERA-34 CHEGUERA-48 CHEGUERA-62 CHEGUERA-75 CHEGUERA-89 CHOLA-11 CHOLA-25 CHOLA-39 CHOLA-52 CHOLA-66 CHOLA-8 CHOLA-94  
CHEGUERA-13 CHEGUERA-35 CHEGUERA-49 CHEGUERA-63 CHEGUERA-76 CHEGUERA-90 CHOLA-12 CHOLA-26 CHOLA-4 CHOLA-53 CHOLA-67 CHOLA-80 CHOLA-94  
dhrshekthvel@dharshekthvel:~/ac/bin/kafka2110102/bin$
```

Kafka Architecture



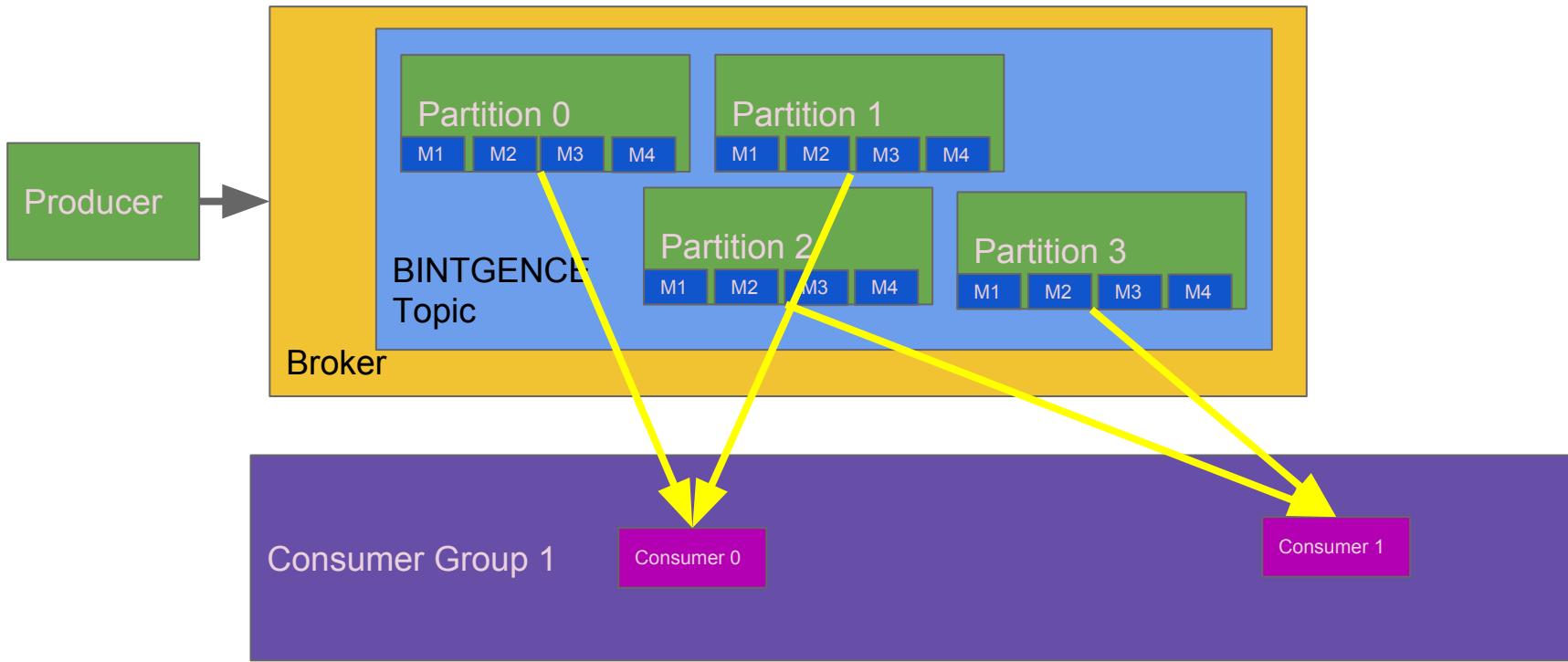
A Topic is stored internally as a partition.

You can specify the number of partitions and replications at the time of creating the topic.

Partitions are stored in the local storage of each of the brokers.

Kafka Architecture

Data in Partition 0 and 1 will be consumed by Consumer 0 and data in Partition 2 and 3 will be consumed by Consumer 1.



Kafka Architecture



Partition - Leader and Followers

Data is written to the leader partition and all the followers passively copy from the leader.

Leader is the one who handles the reads/writes for a particular partition.

Partition

Each partition has a leader.

The producer writes to the leader and the followers just copy data from the leaders log.

A message is said to be committed when the leader writes the data to itself and also replicates the data to its followers (the in-sync replicas (ISR)).

Configs:

replica.lag.max.messages
replica.lag.time.max.ms

Partition - Leader and Followers

Each broker holds many partitions.

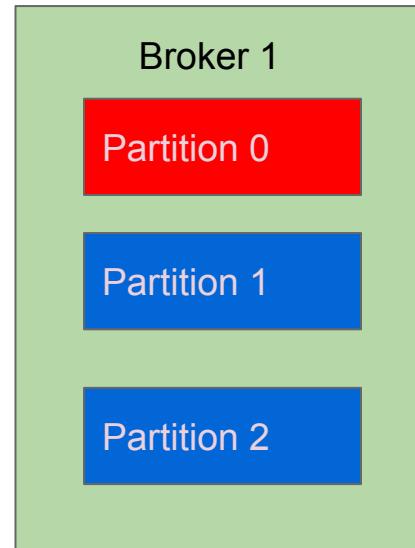
Each partition can be a **leader** or a **replica**.

All writes and reads to a topic go through leader and the leader coordinates updating replicas with new data.

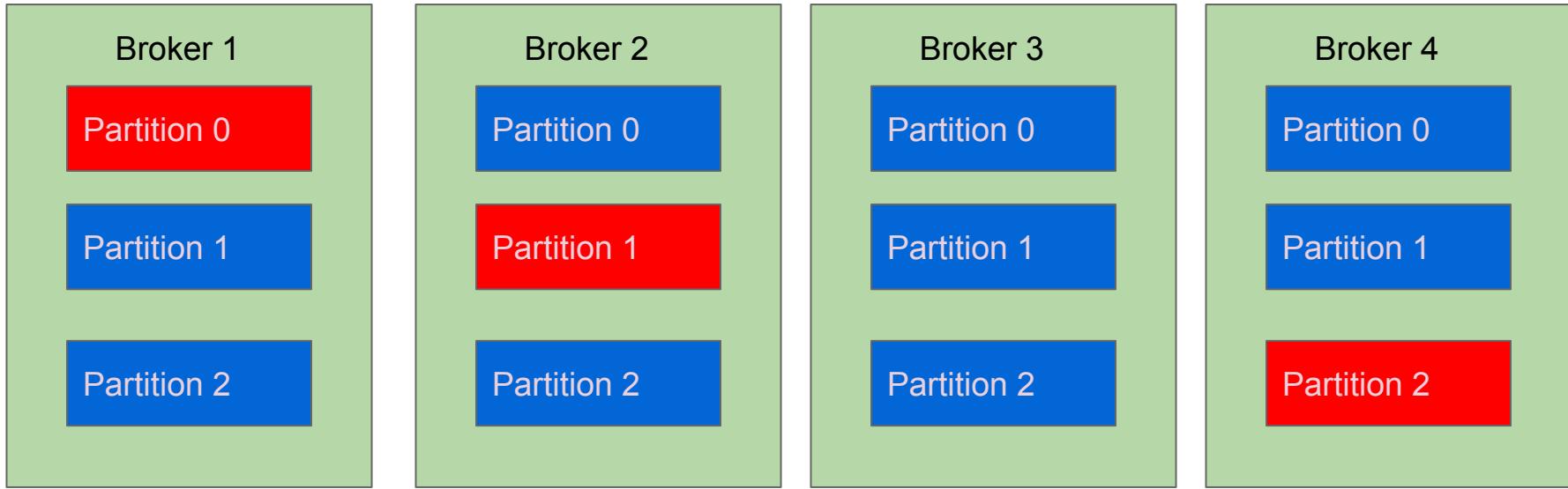
If a leader fails, a replica takes as a new leader.

Partition is a Write-a-head-log.

Write-a-head-log guarantees Atomicity and Durability of ACID property.



Partition



Leader

Follower

Partition

replica.lag.max.messages=4

The max messages that a leader waits on to take a follower out of ISR
Used for slow replicas.

Replica.lag.time.max.ms=100

The max time that a leader waits on to take a follower out of ISR
Used for dead replicas.

Messaging Guarantees

When a producer sends a message to a particular topic, the partition appends the message in the order of how it arrives.

The consumer consumes the messages in the order they are stored in the partition.

Partitions

Description about partitions

./kafka-topics.sh --describe --zookeeper localhost:2181 --topic CHE

Topic:CHE	PartitionCount:20	ReplicationFactor:2	Configs:
Topic: CHE	Partition: 0	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 1	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 2	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 3	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 4	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 5	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 6	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 7	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 8	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 9	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 10	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 11	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 12	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 13	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 14	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 15	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 16	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 17	Leader: 0 Replicas: 0,1	Isr: 0,1
Topic: CHE	Partition: 18	Leader: 1 Replicas: 1,0	Isr: 1,0
Topic: CHE	Partition: 19	Leader: 0 Replicas: 0,1	Isr: 0,1

Analyze the data in Partition

Run the below command to check on the data written inside partition

```
./kafka-run-class.sh kafka.tools.DumpLogSegments --deep-iteration --print-data-log --files  
/tmp/dharshekth-kafka/SLZCHAMBER-1/000000000000000000000000.log
```

Kafka Controller

One of the broker servers as the kafka controller.

Kafka controller takes the responsibility of assigning partitions and managing replicas.

Serializer and Deserializer

For a **producer**, we give in a Serializer in the properties.

```
props.put("key.serializer", "org.apache.kafka.common.serialization.StringSerializer")
props.put("value.serializer", "org.apache.kafka.common.serialization.StringSerializer")
```

For a **consumer**, we give in a Deserializer in the properties.

```
props.put("key.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
props.put("value.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
```



Partition <-> Segments

Partition - Segments

Partition is immutable,
sequence of messages of data,
stored sequentially.

Partition is stored as segments. (or) Partition is split as segments.

When kafka writes to partition, it writes to segment (active segment)

In disk, partition is a directory and each segment is a log file and a index file.

Log file - Where message is stored.

Index file - Contains the index to find data

Partition, Segments

Data is stored in topics as Partitions

The data order is preserved inside the partitions.

Partitions store data in disk as segments.

```
dharshekthvel@dharshekthvel:~/ac/bin/kafka2110102/bin$ tree /tmp/dharshekth-kafka/TIGER-0
/tmp/dharshekth-kafka/TIGER-0
|-- 00000000000000000000.index
|-- 00000000000000000000.log
|-- 00000000000000000000.timeindex
|-- 00000000000000000003.index
|-- 00000000000000000003.log
|-- 00000000000000000003.timeindex
|-- 00000000000000000006.index
|-- 00000000000000000006.log
-- 00000000000000000006.timeindex

0 directories, 9 files
dharshekthvel@dharshekthvel:~/ac/bin/kafka2110102/bin$
```

In the server.properties. Change the *log.segment.bytes*.

The maximum size of a log segment file. When this size is reached a new log segment will be created.

```
#log.segment.bytes=1073741824
log.segment.bytes=200
```

chinnasamyad@gmail.com

Partition - Segments

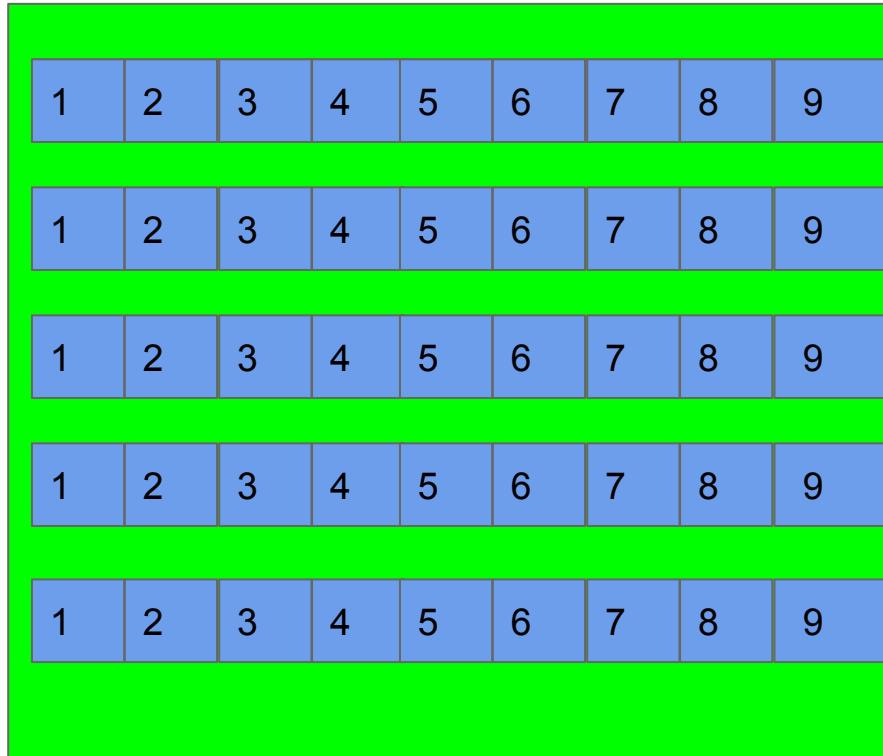
To find the content of the log file and index file, execute the below command.

```
./kafka-run-class.sh kafka.tools.DumpLogSegments --deep-iteration --print-data-log --files  
/tmp/dharshekth-kafka/CHE-18/000000000000000000000000.log
```

```
./kafka-run-class.sh kafka.tools.DumpLogSegments --deep-iteration --print-data-log --files  
/tmp/dharshekth-kafka/CHE-18/000000000000000000000000.index
```

```
./kafka-run-class.sh kafka.tools.DumpLogSegments --deep-iteration --print-data-log --files  
/tmp/dharshekth-kafka/CHE-18/000000000000000000000000.timeindex
```

Producer - Consumers - Partition



Kafka Producer - Java

```
Properties props = new Properties();

props.put("zk.connect", "localhost:2181");
props.put("serializer.class", "kafka.serializer.StringEncoder");
props.put("metadata.broker.list", "localhost:9092");

ProducerConfig config = new ProducerConfig(props);

Producer<String, String> producer = new Producer<String, String>(config);
producer.send(new KeyedMessage<String, String>("Lohith_Topic", "BUSINESS-MESSAGE"));

producer.close();
```

Kafka Producer - Acknowledgement

`props.put("request.required.acks", "0")` - no acknowledgement

`props.put("request.required.acks", "1")` -

producer gets an acknowledgement after the leader gets the data.

`props.put("request.required.acks", "-1")` -

producer gets an acknowledgement after all the ISR (In Sync Replicas) have received the data.

Kafka data retention

Kafka by default keeps the data in the topic upto 7 days. This is present in the configuration *retention.ms*. *The default value of the retention.ms is 604800000.*

The above value can be overridden to any value of choice.

Kafka Consumer

Kafka Consumer

A client which consumes record from the Kafka Cluster, typically from a topic.

Consumers use TCP connections to communicate data.

Consumers are not thread-safe.

Consumer

```
val props = new Properties();
props.put("bootstrap.servers", "localhost:9092");
props.put("group.id", "SLZ-ZONE-GROUP");          // Give a group name
props.put("enable.auto.commit", "true");
props.put("auto.commit.interval.ms", "1000");
props.put("session.timeout.ms", "30000");
props.put("key.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
props.put("value.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");

val consumer = new KafkaConsumer[String, String](props);
consumer.subscribe(util.Collections.singletonList("TIGER"));           // Subscribe the consumer to a TOPIC

while(true) {
  val records=consumer.poll(0)

  for (record<-records.asScala){
    println(record)
  }
}
```

Consumers

To list all the consumers, use the command below.

```
./kafka-consumer-groups.sh --bootstrap-server localhost:9092 --list
```

```
./kafka-consumer-groups.sh --describe --group EWS-TOPIC-GROUP --bootstrap-server localhost:9092
```

Consumers - Broadcast

There can be multiple consumers in a *Consumer-Group*.

Multiple *Consumer-Group* can be subscribed to a topic.

When a producer sends message to a topic, all *Consumer-Group* receives messages.

But only one consumer in a *Consumer-Group* will receive message and processes it.

In order to achieve broadcast, have multiple *Consumer-Group*, so all groups will receive messages.

If you want all your consumers to receive messages, assign them to different consumer groups.

Each message goes to all the consumer groups, but within a *Consumer-Group* it goes to only one consumer.

Consumers - Broadcast

Queue and Topic implementation through Consumer-Broadcast

Kafka Consumer - Java

```
Properties props = new Properties();
props.put("bootstrap.servers", "localhost:9092");

// When changed the consumer group, it behaves as a TOPIC or QUEUE
props.put("group.id", "ECHELON-CONSUMER2");

props.put("enable.auto.commit", "false");
props.put("auto.commit.interval.ms", "1000");
props.put("session.timeout.ms", "30000");
props.put("key.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
props.put("value.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
```

Declare the properties first

Kafka Consumer - Java

```
KafkaConsumer consumer = new KafkaConsumer<>(props);
consumer.subscribe(Arrays.asList("ECHELON-TOPIC"));

while(true) {

    ConsumerRecords<String, String> records = consumer.poll(1);

    for (ConsumerRecord<String, String> record : records) {

        Set<TopicPartition> partitions = consumer.assignment();

        String formattedText = String.format("Key = %s - Value is %s - Offset is %s - Partition is %s - Partitions size = %s ", record.key(),
                                             record.value(),
                                             record.offset(),
                                             record.partition(),
                                             partitions.size());

        System.out.println(formattedText);

    }
}
```

Kafka Consumer - Topic Routing

```
KafkaConsumer consumer = new KafkaConsumer<>(props);
consumer.subscribe(Arrays.asList("ECHELON-TOPIC"));

while(true) {

    ConsumerRecords<String, String> records = consumer.poll(1);
    for (ConsumerRecord<String, String> record : records) {

        // Unsubscribe the consumer from listening to current topic and subscribe to a new topic
        if (record.key().equals("unsubscribe")) {
            consumer.unsubscribe();
            consumer.subscribe(Arrays.asList(record.value()));
        }
    }
}
```

Kafka Consumer - Clean Exit

```
KafkaConsumer consumer = new KafkaConsumer<>(props);
consumer.subscribe(Arrays.asList("ECHELON-TOPIC"));

while(true) {

    ConsumerRecords<String, String> records = consumer.poll(1);
    boolean shouldConsumerBeClosed = false;

    for (ConsumerRecord<String, String> record : records) {

        // Closing and coming out clean from a consumer
        if (record.key().equals("exit"))
            shouldConsumerBeClosed = true;

    }

    if (shouldConsumerBeClosed) {
        consumer.close();
        break;
    }
}
```

Kafka Consumer - Consume from a specific partition

Consumer can consume from a specific partition. The below code will consume from a specific partition 10.

```
KafkaConsumer consumer = new KafkaConsumer<String, String>(props);  
  
TopicPartition partition2 = new TopicPartition("VEH-TOPIC", 10);  
consumer.assign(Arrays.asList(partition2));  
  
while (true) {  
    ConsumerRecords records = consumer.poll(1);  
  
    records.forEach(new ForEachDataIteration());  
}  
}
```

Kafka Consumer - Multiple Consumers

```
Properties props = new Properties();
props.put("bootstrap.servers", "localhost:9092");

props.put("group.id", "ECHELON-CONSUMER-GROUP");

props.put("enable.auto.commit", "false");
props.put("auto.commit.interval.ms", "1000");
props.put("session.timeout.ms", "30000");
props.put("key.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
props.put("value.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
```

IMPORTANT

To create multiple consumers. Run the code under the **Same** group. Here the group is **ECHELON-CONSUMER-GROUP**.

Kafka Consumer - Topic and Queue

```
Properties props = new Properties();
props.put("bootstrap.servers", "localhost:9092");

// When changed the consumer group, it behaves as a TOPIC or QUEUE
props.put("group.id", "ECHELON-CONSUMER-GROUP");

props.put("enable.auto.commit", "false");
props.put("auto.commit.interval.ms", "1000");
props.put("session.timeout.ms", "30000");
props.put("key.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
props.put("value.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
```

IMPORTANT

When the group is **changed**,
the consumer will behave as a topic else
it will be a queue. Here the group is
ECHELON-CONSUMER-GROUP.

Kafka Consumer - seekToBeginning

```
Set<TopicPartition> partitions = consumer.assignment();
```

```
if (record.key().equals("seektobeginning"))
    consumer.seekToBeginning(partitions);
```

Kafka Consumer - seekToEnd

```
Set<TopicPartition> partitions = consumer.assignment();
```

```
if (record.key().equals("seektoend"))
    consumer.seekToEnd(partitions);
```

Kafka Consumer - Commit your offset

Consumer consuming the offset can commit the offset automatically or programmatically

```
val consumer = new KafkaConsumer[String, String](props)

// Consumer consuming from a Particular Topic
consumer.subscribe(Arrays.asList("AWS"))

while (true) {
    val records = consumer.poll(1)

    records.forEach(new ForEacher)

    // Non-Blocking commit.
    consumer.commitAsync()

    // Blocking commit until the offsets has been successfully committed.
    consumer.commitSync()

}
```

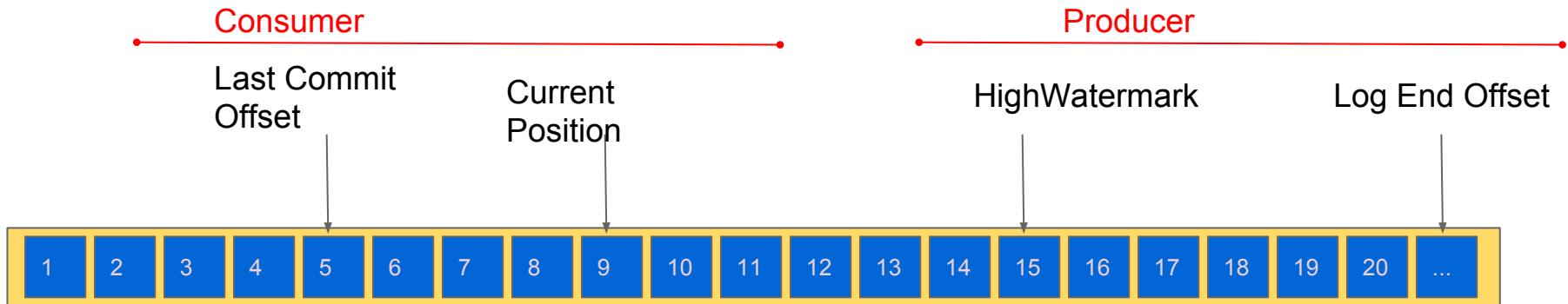
Message - Offset

Offset

Kafka maintains a numerical pointer to each of partition called by the name **offset**.

Consumer identify the data in the segment using a pointer call Offset. (or) The position of the consumer is known by looking at the partition offset.

Partition - Offset



Kafka Partition - Offset

ISR In Sync Replica

LCO Last Committed Offset

LEO Log End Offset

HW High Watermark

CP Current Position

Last Committed Offset - It is the last offset that is committed by a consumer.

Current Position - It is the current position of the consumer where it reads messages.

Log End Offset (LEO) is the offset that a producer writes to the partition.

High Watermark (HW) is the offset of messages that are fully replicated.

Log End Offset is always higher than HW.

Consumers can only consume messages up to high water mark, meaning $CP < HW$

Kafka Partition - Offset

ISR In Sync Replica

LCO **Last Committed Offset**

The LCO is the committed offset that has been saved. If the consumer process fails and restart, the consumer will restart its consuming from the LCO.

LEO Log End Offset

HW High Watermark

CP Current Position

Offset

The offset acts a unique identifier for a particular partition.

The offset progresses forward each time when the consumer receives call through poll() method.

OFFSET

Finding the Offset for a partition

```
$ ./kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group CHE-GROUP
```

```
$ ./kafka-console-consumer.sh --consumer.config /tmp/consumer.config --formatter "kafka.coordinator.GroupMetadataManager\$OffsetsMessageFormatter" --bootstrap-server localhost:9092 --topic __consumer_offsets
```

Offset - Deep Dive

```
$ bin/kafka-run-class.sh kafka.tools.ConsumerOffsetChecker --zookeeper localhost:2181 --group AWS-CONSUMER3 --topic METROLINX-TOPIC
```

[or]

```
$ bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group AWS-CONSUMER3
```

Use the above commands to find out the details of the message that has been consumed by the consumer and the messages that have been produced by the producer.

Offset - Deep Dive

```
$ bin/kafka-run-class.sh kafka.tools.ConsumerOffsetChecker --zookeeper localhost:2181 --group AWS-CONSUMER3 --topic METROLINX-TOPIC
```

```
dharshekthvel@dharshekthvel:~/ac/bin/kafka21101100/bin$ ./kafka-run-class.sh kafka.tools.ConsumerOffsetChecker --zookeeper localhost:2181 --group AWS-CONSUMER3 --topic METROLINX-TOPIC
```

```
[2017-10-24 16:53:18,965] WARN WARNING: ConsumerOffsetChecker is deprecated and will be dropped in releases following 0.9.0. Use ConsumerGroupCommand instead.  
(kafka.tools.ConsumerOffsetChecker$)
```

Group	Topic	Pid	Offset	logSize	Lag	Owner	
AWS-CONSUMER3	METROLINX-TOPIC		0	3	6	3	none

[or]

```
dharshekthvel@dharshekthvel:~/ac/bin/kafka21101100/bin$ ./kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group AWS-CONSUMER3
```

Note: This will only show information about consumers that use the Java consumer API (non-ZooKeeper-based consumers).

TOPIC	PARTITION	CURRENT-OFFSET	LOG-END-OFFSET	LAG	CONSUMER-ID	HOST	CLIENT-ID
METROLINX-TOPIC	0	6	7	1	consumer-1-837f97e0-277d-4f00-8e33-804ca6436508	/127.0.0.1	consumer-1

Offset - Deep Dive

```
dharshekthvel@dharshekthvel:~/ac/bin/kafka21101100/bin$ ./kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group AWS-CONSUMER3
```

Note: This will only show information about consumers that use the Java consumer API (non-ZooKeeper-based consumers).

TOPIC	PARTITION	CURRENT-OFFSET	LOG-END-OFFSET	LAG	CONSUMER-ID	HOST	CLIENT-ID
REDIS-TOPIC	0	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	1	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	12	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	13	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	14	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	15	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	16	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	17	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	18	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	19	0	0	0	consumer-1-1e7b2af0-942f-4083-9ebc-d279b0790d3a	/127.0.0.1	consumer-1
REDIS-TOPIC	98	0	0	0	consumer-1-eef4cbd3-1977-405f-bb4f-d394046266ac	/127.0.0.1	consumer-1
REDIS-TOPIC	99	0	0	0	consumer-1-eef4cbd3-1977-405f-bb4f-d394046266ac	/127.0.0.1	consumer-1
METROLINX-TOPIC	0	7	7	0	-	-	-

```
dharshekthvel@dharshekthvel:~/ac/bin/kafka21101100/bin$
```

Kafka Partition Data Replication

The High Watermark is updated by calculating,

Minimum LEO across all the ISR of the partition.

```
/*
 * Check and maybe increment the high watermark of the partition;
 * this function can be triggered when
 *
 * 1. Partition ISR changed
 * 2. Any replica's LEO changed
 *
 * Returns true if the HW was incremented, and false otherwise.
 * Note There is no need to acquire the leaderIsrUpdate lock here
 * since all callers of this private API acquire that lock
 */
private def maybeIncrementLeaderHW(leaderReplica: Replica): Boolean = {
  val allLogEndOffsets = inSyncReplicas.map(_.logEndOffset)
  val newHighWatermark = allLogEndOffsets.min(new
    LogOffsetMetadata.OffsetOrdering)
  val oldHighWatermark = leaderReplica.highWatermark
  if (oldHighWatermark.messageOffset <
    newHighWatermark.messageOffset ||
    oldHighWatermark.onOlderSegment(newHighWatermark)) {
    leaderReplica.highWatermark = newHighWatermark
    debug("High watermark for partition [%s,%d] updated to
      %s".format(topic, partitionId, newHighWatermark))
    True
  } else {
    debug("Skipping update high watermark since Old hw %s is larger than new hw %
      for partition [%s,%d]. All leo's are %s"
      .format(oldHighWatermark, newHighWatermark, topic, partitionId,
        allLogEndOffsets.mkString(",")))
    false
  }
}
```

Kafka Installation

Use console producer to produce messages. The below command produces messages from the console.

```
./kafka-console-producer.sh --broker-list localhost:9092 --topic Lohith_Topic
```

Kafka consumer group - list

```
$ bin/kafka-consumer-groups.sh -bootstrap-server=localhost:9092 --list
```

The above command will list the consumer groups connected to the kafka.

```
dharshekthvel@dharshekthvel:~/ac/bin/kafka21101100/bin$ ./kafka-consumer-groups.sh -bootstrap-server=localhost:9092 --list  
Note: This will only show information about consumers that use the Java consumer API (non-ZooKeeper-based consumers).
```

AWS-CONSUMER3

Consumer Rebalancing

Consumer Rebalancing

A consumer rebalancing happens, when :

1. A topic partition is added or removed.
2. A consumer is added or removed from the consumer-group.
3. A consumer shuts-down cleanly.

When any one of the above happens,

The partition rebalancing algorithm kicks in and all the partitions are assigned to the consumer groups.

Consumer - GroupCoordinator and GroupLeader

GroupCoordinator and **GroupLeader**

Groupcoordinator is one of the broker.

Groupleader is one of the consumer.

GroupCoordinator is one of the brokers which receives heartbeats from all consumers of a consumer group.

Every consumer group has a GroupCoordinator. If a consumer stops sending a heart-beat, then a GroupCoordinator will trigger a re-balance.

When a consumer wants to join a group, it sends a JoinGroup request to the GroupCoordinator.

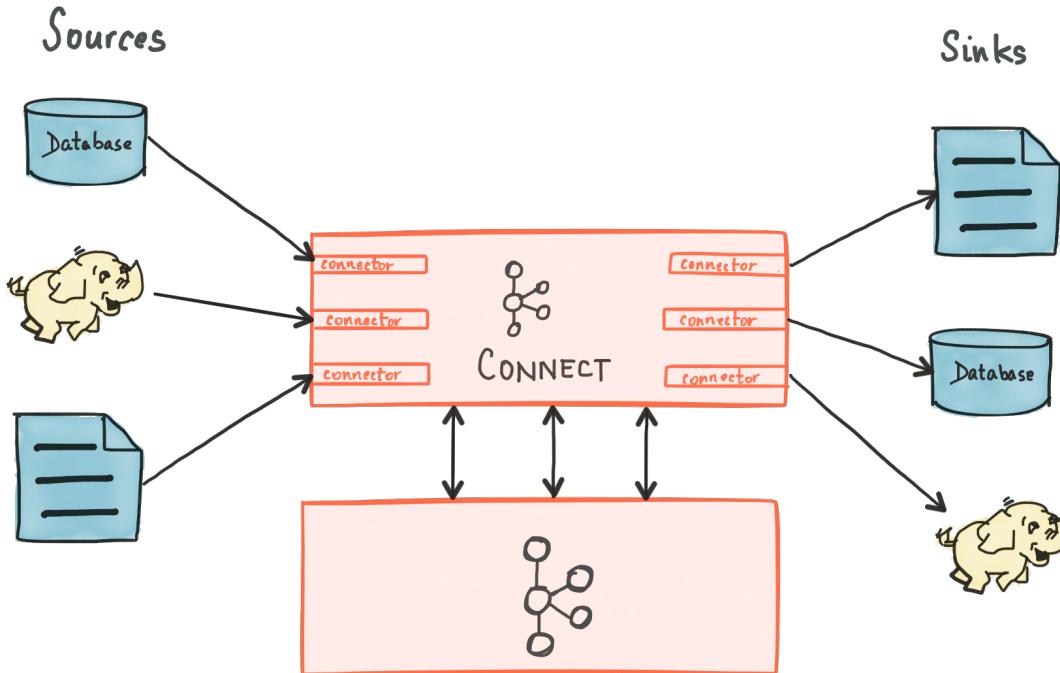
The first consumer to join the group becomes the GroupLeader.

The leader receives a list of all consumers in the group from the group coordinator (this will include all consumers that sent a heartbeat) and it is responsible for assigning a subset of partitions to each consumer. After deciding on the partition assignment, the consumer leader sends the list of assignments to the GroupCoordinator which sends this information to all the consumers.

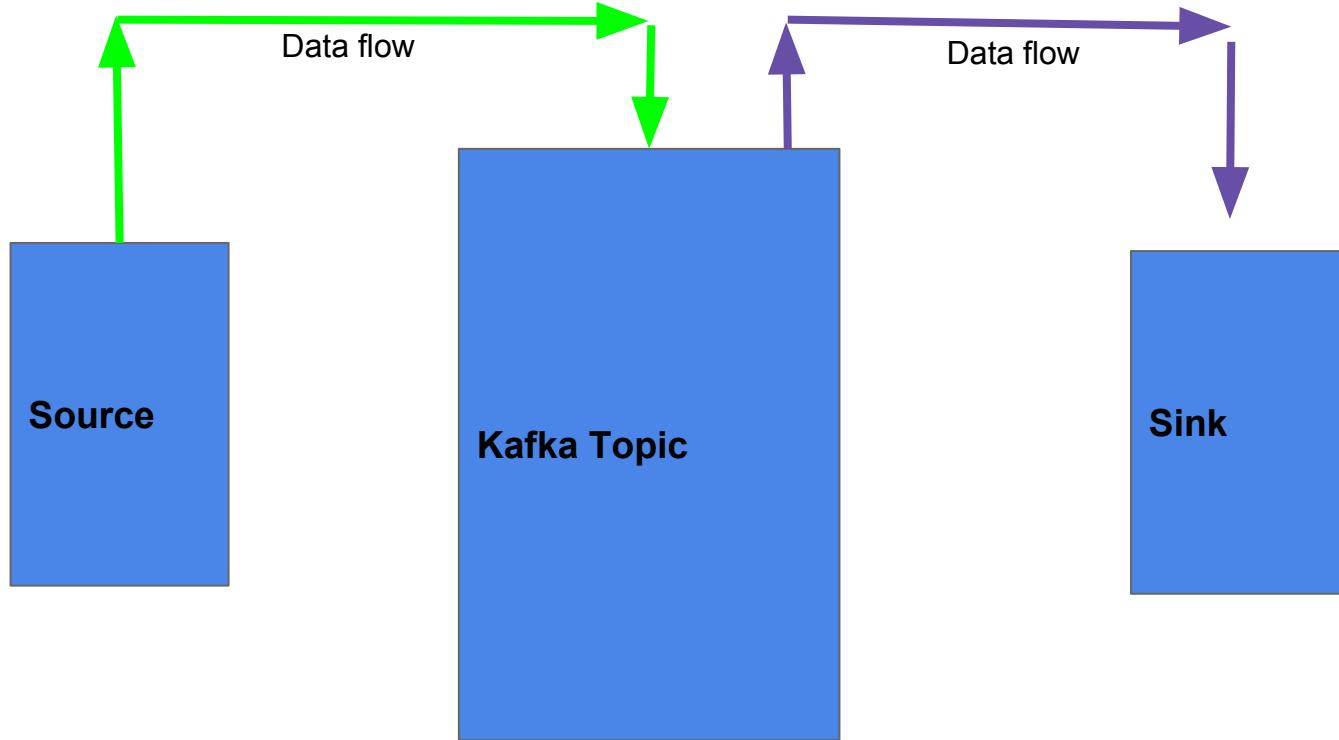


Kafka Connect

Kafka Connect



Kafka Connect



Kafka Connect

Apache Kafka Connect supports quick define connectors that move large collections of data from other systems to kafka and from kafka to other systems.

To integrate with systems through ease of development for Kafka.

Kafka Connect

Standalone mode

`kafka/bin/connect-standalone.sh`

Distributed mode

`kafka/bin/connect-distributed.sh`

Kafka Connect

./connect-standalone.sh

..../config/connect-standalone.properties

..../config/connect-file-source.properties

..../config/connect-file-sink.properties

Kafka Connect - Source - File to Kafka Topic

```
$ ./connect-standalone.sh .../config/connect-standalone.properties .../config/connect-file-source.properties
```

connect-file-source.properties

```
name=INTELLIGENCE-SOURCE  
connector.class=FileStreamSource  
tasks.max=1  
file=intellisource.txt  
topic=BINTELLIGENCE
```

connect-standalone.properties

```
bootstrap.servers=localhost:9092  
  
#key.converter=org.apache.kafka.connect.json.JsonConverter  
#value.converter=org.apache.kafka.connect.json.JsonConverter  
  
key.converter=org.apache.kafka.connect.storage.StringConverter  
value.converter=org.apache.kafka.connect.storage.StringConverter  
  
key.converter.schemas.enable=true  
value.converter.schemas.enable=true
```

Kafka Connect - Sink - Kafka Topic to HDFS

Download the confluent.

In the bin directory of the confluent, give in the below command. Both the config files are there in etc/ directory of the confluent.

```
$ ./connect-standalone .../etc/kafka/connect-standalone.properties .../etc/kafka-connect-hdfs/quickstart-hdfs.properties
```

connect-file-source.properties

```
name=hdfs-sink  
connector.class=io.confluent.connect.hdfs.HdfsSinkConnector  
tasks.max=1  
topics=HDFS-TOPICONE  
hdfs.url=hdfs://localhost:9000/hdfs kafka  
flush.size=3  
schemas.enable=false
```

connect-standalone.properties

```
bootstrap.servers=localhost:9092  
  
key.converter.schemas.enable=false  
value.converter.schemas.enable=false  
  
key.converter=org.apache.kafka.connect.storage.StringConverter  
value.converter=org.apache.kafka.connect.storage.StringConverter  
  
internal.key.converter=org.apache.kafka.connect.storage.StringConve  
rter  
internal.value.converter=org.apache.kafka.connect.storage.StringCon  
verter  
internal.key.converter.schemas.enable=false  
internal.value.converter.schemas.enable=false
```

Kafka Compression

Kafka supports data compression

Data is compressed by the producer.

Data is written in a compressed format on the server.

Data is decompressed by the consumer.

Data compression improves consumer throughput at the cost of decompression.

Kafka supports the following compression algos

GZIP Compression

Snappy Compression

LZ4 Compression

Kafka config for compression

compression.codec

Specify which algorithm to be used by producer.
Default is 0.

compressed.topics

Compression on a topic level.
Default is empty.

Kafka config for compression

compression.codec

- 0 default
- 1 GZIP compression
- 2 Snappy compression
- 3 LZ4 compression

compressed.topics

“topic_ONE, topic_TWO”

Kafka Streams



KAFKA STREAMS:
Stream processing made simple

Kafka Streams

- 1. Processor API - Low Level API
- 2. Kafka Streams DSL - High Level API

Processor API

1. Create Streams Config

```
StreamsConfig config = new StreamsConfig(settings);
```

2. Build the TopologyBuilder

```
TopologyBuilder builder = new TopologyBuilder();
```

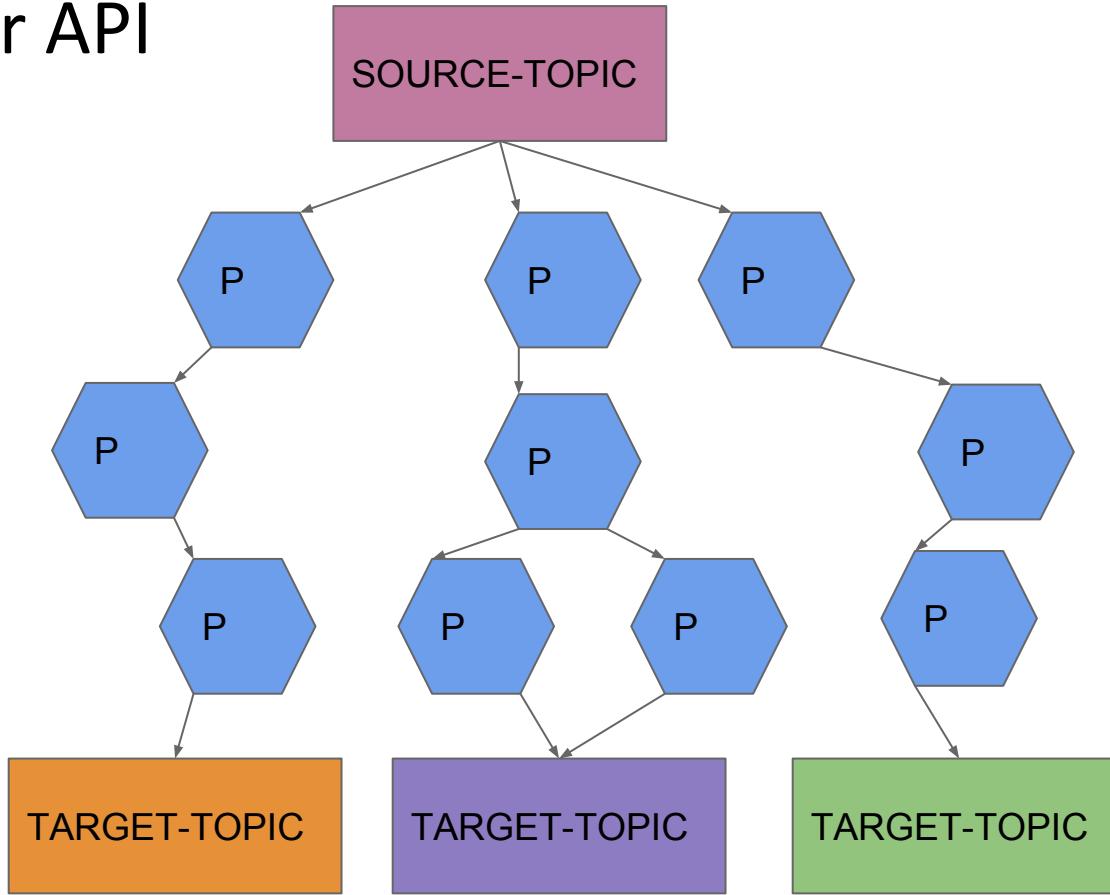
3. Create the KafkaStreams

```
KafkaStreams streams = new KafkaStreams(builder, config);
```

4. Start the streams

```
streams.start();
```

Processor API



Processor API - Topology Builder

1. Source
2. Processor
3. Sink
4. State Store

```
TopologyBuilder builder = new TopologyBuilder();
builder.addSource("Source", "BINTELLIGENCE")

.addProcessor("Process", new DataProcessSupplier(), "Source")

.addStateStore(dataStore, "Process")

.addSink("Sink", "P-INTELLIGENCE", "Process");
```

Processor API - Topology Builder - Processor

```
public class DataProcessSupplier implements ProcessorSupplier<String, String> {
    @Override
    public Processor<String, String> get() {
        return new DataProcessor();
    }
}

public class DataProcessor implements Processor<String, String> {
    @Override
    public void init(ProcessorContext processorContext) {
    }

    @Override
    public void process(String key, String value) {
        System.out.println(key + value);
    }

    @Override
    public void punctuate(long l) {
    }

    @Override
    public void close() {
    }
}
```

Processor API

The topology is nothing but a Acyclic graph of sources, processors and sinks.

Internally, it uses List, Set and Map as the basic data structure to construct the topology.

Building a complex topology

```
TopologyBuilder builder = new TopologyBuilder();

builder.addSource("Source", "DATASOURCE-TOPIC")
    .addProcessor("CAPITAL-PROCESSOR",new DataProcessSupplier(), "Source")
    .addProcessor("CAPITAL-LENGTH-PROCESSOR",new CapitalToLengthSupplier(), "CAPITAL-PROCESSOR")
    .addStateStore(dataStore, "CAPITAL-PROCESSOR")
    .addStateStore(lengthStore, "CAPITAL-LENGTH-PROCESSOR")
    .addSink("DataSink","DATA-OCEAN-TOPIC", "CAPITAL-PROCESSOR")
    .addSink("LengthSink","DATA-LENGTH-TOPIC", "CAPITAL-LENGTH-PROCESSOR");
```

```
KafkaStreams streams = new KafkaStreams(builder, config);
streams.start();
```

Building a complex topology

```
class CapitalToLengthSupplier implements ProcessorSupplier<String, String> {  
    @Override  
    public Processor<String, String> get() {  
        return new LetterToLengthProcessor();  
    }  
}
```

```
class LetterToLengthProcessor implements Processor<String, String> {  
  
    ProcessorContext processorContext = null;  
    private KeyValueStore<String, String> kvStore = null;  
  
    @Override  
    public void init(ProcessorContext _processorContext) {  
  
        this.processorContext = _processorContext;  
        kvStore = (KeyValueStore)  
        _processorContext.getStateStore("LENGTH_STORE");  
  
        // call the punctuate  
        this.processorContext.schedule(1000);  
    }  
  
    @Override  
    public void process(String key, String value) {  
  
        // Do complex processing and forward it to next topic  
        processorContext.forward(Integer.toString(key.length()),  
        Integer.toString(value.length()));  
        kvStore.put(Integer.toString(key.length()), Integer.toString(value.length()));  
    }  
  
    @Override  
    public void punctuate(long l) {  
        processorContext.commit();  
    }  
  
    @Override  
    public void close() {  
  
        kvStore.close();  
    }  
}
```

Kafka Streams DSL

KStream

KTable

GlobalKTable

KGroupedStream

Kafka Streams DSL

KStream - A record stream. Data is INSERT here.

KTable - Changelog stream. Date is UPDATE here based on key. If key not found, then INSERT.

GlobalKTable - Changelog stream.

Kafka Streams DSL

1. Create the KStreamBuilder

```
val builder = new KStreamBuilder
```

2. Connect to a topic and create a stream

```
val users : KStream[String, String] = builder.stream(Serdes.String(), Serdes.String(), "BINT")
```

3. Code one or more transformations and one terminal operations.

```
users.foreach(new Printer)
```

4. Create kafka stream and start the streaming

```
val stream = new KafkaStreams(builder, props)  
stream.start()
```

Kafka Streams - Transformation operations

map()

groupBy()

mapValues()

groupByKey()

filter()

join()

filterNot()

flatMap()

flatMapValues()

Kafka Streams - Terminal Operations

foreach()

print()

writeAsText("")

peek()

Kafka Streams - map()

```
KStreamBuilder builder = new KStreamBuilder();  
  
KStream data = builder.stream(Serdes.String(), Serdes.String(), "Squad-Topic");  
  
//KStream mappedValuesData = data.mapValues(each -> each.toString().toUpperCase());  
KStream mappedData = data.map(((key, value) -> new KeyValue<>(key.toString().toUpperCase(),  
value.toString().toUpperCase())));
```

Kafka Streams - mapValues()

```
KStream data = builder.stream(Serdes.String(), Serdes.String(), "Squad-Topic");  
KStream mappedValuesData = data.mapValues(each -> each.toString().toUpperCase());
```

Kafka Streams - filter()

```
KStream filteredData = mappedData.filter((key, value) -> key.toString().startsWith("A"));
```

Kafka Streams - filterNot()

```
KStream inverseFilteredData = mappedData.filterNot((key, value) -> key.toString().startsWith("A"));
```

Kafka Streams - foreach()

```
mappedData.foreach((key,value) -> System.out.println("The key is " + key + " and value is " + value));
```

Kafka Streams - peek()

```
mappedData.peek((key,value) -> System.out.println("The key is " + key + " and value is " + value));
```

Kafka Streams - branch

```
KStream<String, String>[] branches = mappedData.branch((key, value) ->
    value.toString().startsWith("MESH"),
        (key, value) -> value.toString().startsWith("CONTRACT"),
        (key, value) -> true
    );
```

```
KStream meshData = branches[0];
KStream contractData = branches[1];
KStream allOtherData = branches[2];
```

Kafka Streams - Data transfer to other topic to

```
mappedData.foreach((key,value) -> System.out.println("The key is " + key + " and value is " + value));
```

```
mappedData.to("Squad-SVM-Model");
```

Kafka Streams - Data transfer to other topic through

```
mappedData.through("Squad-SVM-Model")
    .map(((key, value) -> new KeyValue<>(key.toString().length(), value.toString().length())))
    .print();
```

Kafka Streams - groupByKey()

```
val builder = new KStreamBuilder  
val data = builder.stream(Serdes.String, Serdes.String, "BDAS")  
  
val groupedStream:KGroupedStream[String, String] = data.groupByKey()
```

groupByKey() returns a KGroupedStream.

Only in a KGroupedStream datastructure you can perform a reduce() operation.

Kafka Streams - count()

```
val groupedStream:KGroupedStream[String, String] = data.groupByKey()
```

```
val countAgg = groupedStream.count()
```

count() operation is available on a grouped stream only.

Remember: The count() transformation always return a KTable.

Kafka Streams - Exception Handling

To catch an unexpected exception, the `UncaughtExceptionHandler` has to be coded and logged.

```
KafkaStreams stream = new KafkaStreams(builder, props);

stream.setUncaughtExceptionHandler(new Thread.UncaughtExceptionHandler() {
    @Override
    public void uncaughtException(Thread t, Throwable e) {
        System.out.println(e.getMessage());
    }
});
```

After all the computations, close the stream.
`stream.close();`

Kafka Streams - KTable

```
KStreamBuilder builder = new KStreamBuilder();
```

```
KTable data = builder.table(Serdes.String(), Serdes.String(), "KTABLE-TOPIC");
```

```
data.toStream().foreach((x,y) -> System.out.println("Key = " + x + " Value" + y));
```

```
Properties props = new Properties();
props.put(StreamsConfig.APPLICATION_ID_CONFIG, "KTABLEJOB");
props.put(StreamsConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:9092");
props.put(StreamsConfig.DEFAULT_VALUE_SERDE_CLASS_CONFIG, Serdes.String().getClass().getName());
props.put(StreamsConfig.DEFAULT_KEY_SERDE_CLASS_CONFIG, Serdes.String().getClass().getName());
props.put(StreamsConfig.CACHE_MAX_BYTES_BUFFERING_CONFIG, 1000L);
```

```
KafkaStreams stream = new KafkaStreams(builder, props);
```

```
stream.start();
```

Kafka Streams - KTable - Best Practice

```
KStreamBuilder builder = new KStreamBuilder();  
  
KTable data = builder.table(Serdes.String(), Serdes.String(), "KTABLE-TOPIC");  
  
data.toStream().foreach((x,y) -> System.out.println("Key = " + x + " Value" + y));
```

Always do a toStream() and do the data manipulations.

Kafka Streams - KTable - Transformations

```
KStreamBuilder builder = new KStreamBuilder();
```

```
KTable data = builder.table(Serdes.String(), Serdes.String(), "KTABLE-TOPIC");
```

```
data.filter()
```

```
data.filterNot()
```

```
data.groupBy()
```

```
data.join()
```

```
data.leftJoin()
```

```
data.outerJoin()
```

```
data.through()
```

```
data.to();
```

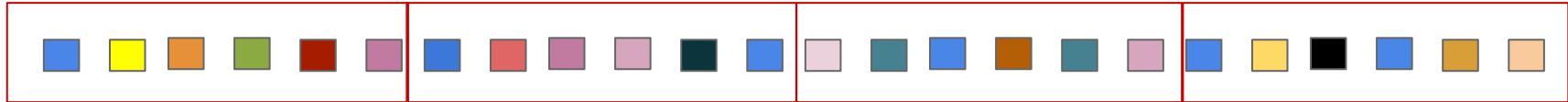
The following are the transformation supported by the KTable. Not all KStream transformation is supported by KTable.

Kafka Streams - Windowing

Tumbling time window

Hopping time window

Kafka Streams - Tumbling time window



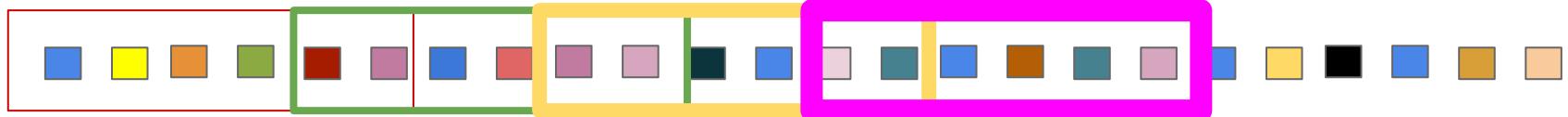
```
alerts.map[String, String](new MapData)
    .groupByKey()

    .count(TimeWindows.of(TimeUnit.SECONDS.toMillis(60)), "alert-store")

    .toStream

    .foreach(new PrinterAllData)
```

Kafka Streams - Hoping time window



```
alerts.map[String, String](new MapData)
    .groupByKey()
    .count(TimeWindows.of(TimeUnit.SECONDS.toMillis(60)))
        .advanceBy(TimeUnit.SECONDS.toMillis(30)), "alert-store")

    .toStream

    .foreach(new PrinterAllData)
```

Kafka ACL

Access Control List

Kafka ACL

First enable the ACL for kafka

[1] In the server.properties, add the following below two lines:

```
authorizer.class.name=kafka.security.auth.SimpleAclAuthorizer  
super.users=User:dharshekthvel
```

Then restart the zookeeper and kafka.

Kafka ACL - Commands

```
authorizer.class.name=kafka.security.auth.SimpleAclAuthorizer
```

```
./kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic HULKER
```

```
./kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:* --operation ALL --topic BASHAS
```

```
./kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:* --operation WRITE --topic HULK
```

```
./kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:* --producer --topic HULKER
```

```
./kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --authorizer kafka.security.auth.SimpleAclAuthorizer --add  
--allow-principal User:* --producer --topic BASHAS
```

```
./kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --authorizer kafka.security.auth.SimpleAclAuthorizer --add  
--allow-principal User:* --consumer --topic BASHAS --group *
```

```
./kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --deny-principal User:* --operation ALL --topic DATAS
```

```
./kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --list --topic FARM-TOPIC
```

Kafka ACL - To turn debugging on

```
log4j.logger.kafka.authorizer.logger=DEBUG, authorizerAppender  
log4j.additivity.kafka.authorizer.logger=false
```

```
log4j.appendер.authorizerAppender=org.apache.log4j.DailyRollingFileAppender  
log4j.appendер.authorizerAppender.DatePattern='yyyy-MM-dd-HH  
log4j.appendер.authorizerAppender.File=${kafka.logs.dir}/kafka-authorizer.log  
log4j.appendер.authorizerAppender.layout=org.apache.log4j.PatternLayout  
log4j.appendер.authorizerAppender.layout.ConversionPattern=[%d] %p %m (%c)%n
```

Kafka Best Practices

Kafka Best Practices

- [1] Keep zookeeper in a separate node.
- [2] Choose the right filesystem. XFS and EXT are good.
- [3] If throughput < network_capacity
 - Add more producers
 - Add more partitions
 - Add more consumers

Kafka Best Practices - Zero Data Loss Settings

Producer:

```
Retries = Long.MAX_VALUE      props.put("retries", Integer.MAX_VALUE);
Acks = all                    props.put("request.required.acks", "-1");
Close producer cleanly
```

Broker:

```
Replication factor >= 3
min.insync.replicas >= 2
```

Consumer:

Always commit manually, don't do auto-commit.

Kafka - Zookeeper

Kafka - Zookeeper

Let's deep dive into how kafka interacts with zookeeper.

[1] Lets create a topic with name BULK_LOADER with 100 partitions.

```
./kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 1 --partitions 100 --topic BULK_LOADER
```

[2] Kick on the zookeeper cli and put a ls on the below path:

In the zookeeper-CLI, give in the below command.

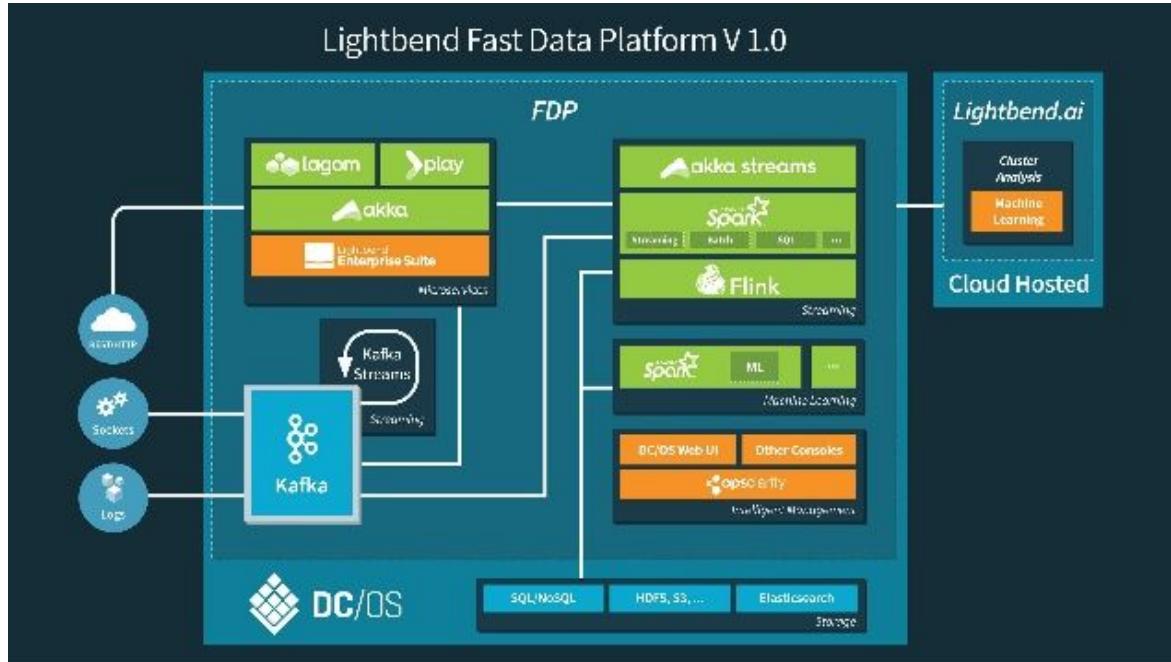
```
$ ls /brokers/topics/BULK_LOADER/partitions  
You will see 100 partitions on it.
```

```
$ ls /brokers/topics/BULK_LOADER/partitions/85/state
```

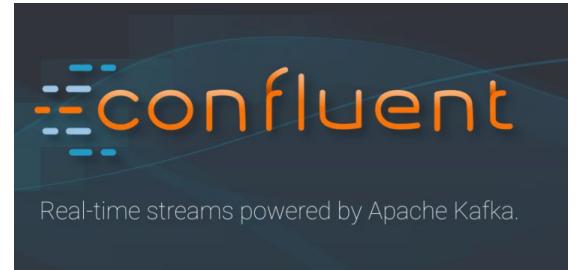
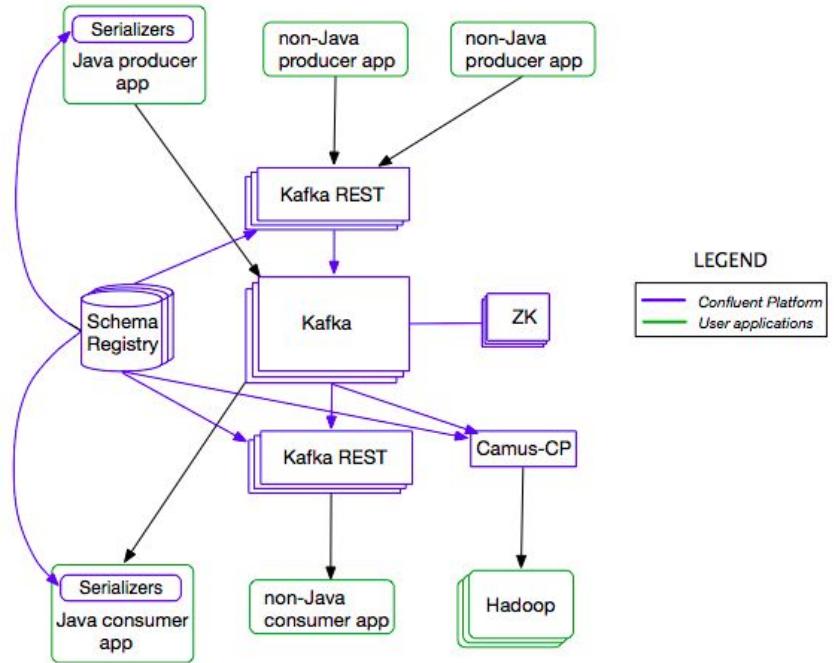
[3] Top list the brokers attached to the zookeeper

```
$ ls /brokers/ids
```

Lightbend fast data platform



Kafka REST



CDC - Change Data Capture

Change Data Capture is mechanism by which the downstream systems are updated whenever there is an update in the database.

Mysql has a CDC from maxwell and debezium.

<http://maxwells-daemon.io/>

<http://debezium.io>

ELK Stack

Elasticsearch

Logstash

Kibana



Elasticsearch

It offers a competitive edge over splunk



Elasticsearch Installation

[1] Download ElasticSearch 1.7.2 from

<https://www.elastic.co/downloads/elasticsearch>

[2] Download JDK and set the JAVA_HOME variable

[3] Extract the elastic.elasticsearch-1.7.2.zip file.

[4] After the extraction, go inside the *elasticsearch/bin* directory and run the *elasticsearch.bat* to start the elasticsearch.

Elasticsearch Installation

```
ca| Elasticsearch 1.7.2

D:\elasticsearch172\bin>dir
Volume in drive D has no label.
Volume Serial Number is 264F-D60B

Directory of D:\elasticsearch172\bin

10/13/2015  02:40 PM    <DIR>          .
10/13/2015  02:40 PM    <DIR>          ..
10/13/2015  02:40 PM           8,114 elasticsearch
10/13/2015  02:40 PM        104,448 elasticsearch-service-mgr.exe
10/13/2015  02:40 PM        103,936 elasticsearch-service-x64.exe
10/13/2015  02:40 PM        80,896 elasticsearch-service-x86.exe
10/13/2015  02:40 PM           901 elasticsearch.bat
10/13/2015  02:40 PM           2,797 elasticsearch.in.bat
10/13/2015  02:40 PM           2,170 elasticsearch.in.sh
10/13/2015  02:40 PM           2,523 plugin
10/13/2015  02:40 PM           482 plugin.bat
10/13/2015  02:40 PM           6,210 service.bat
                           10 File(s)   312,477 bytes
                           2 Dir(s)  49,467,441,152 bytes free

D:\elasticsearch172\bin>elasticsearch.bat
[2015-10-13 15:03:49,825][INFO ][node] [Hydro] version[1.7.2]
[2015-10-13 15:03:49,826][INFO ][node] [Hydro] pid[3472], build[fe43676b/2015-09-14T09:49:53Z]
[2015-10-13 15:03:49,826][INFO ][node] [Hydro] initializing
[2015-10-13 15:03:50,154][INFO ][plugins] [Hydro] loaded [1], s
ites []
[2015-10-13 15:03:50,328][INFO ][env] [Hydro] using [1] da
ta paths, mounts [[(D:)]], net usable_space [46gb], net total_space [50.7gb], ty
pes [NTFS]
[2015-10-13 15:03:58,486][INFO ][node] [Hydro] initialized
[2015-10-13 15:03:58,487][INFO ][node] [Hydro] starting ...
[2015-10-13 15:03:58,935][INFO ][transport] [Hydro] bound_addres
s {inet[/0:0:0:0:0:0:9300]}, publish_address {inet[/10.15.10.137:9300]}
[2015-10-13 15:03:59,376][INFO ][discovery] [Hydro] elasticsearc
h/UOWFiaLgQX-1ibBSNQcr5A
[2015-10-13 15:04:03,238][INFO ][cluster.service] [Hydro] new_master [
Hydro][UOWFiaLgQX-1ibBSNQcr5A][2400002720-LT33][inet[/10.15.10.137:9300]], reaso
n: zen-disco-join {elected_as_master}
[2015-10-13 15:04:03,373][INFO ][gateway] [Hydro] recovered [0]
[2015-10-13 15:04:03,385][INFO ][http] [Hydro] bound_addres
s {inet[/0:0:0:0:0:0:9200]}, publish_address {inet[/10.15.10.137:9200]}
[2015-10-13 15:04:03,386][INFO ][node] [Hydro] started
```

Elasticsearch Installation

```
bin — java -Xms256m -Xmx1g -Djava.awt.headless=true -XX:+UseParNewGC -XX:+UseConcMarkSweepGC -XX:CMSInitiatingOccupancyFraction=75 -XX:+UseCMSInitiatingOccupancyFraction=75  
elasticsearch-service-mgr.exe  elasticsearch.in.sh  
elasticsearch-service-x64.exe  plugin  
elasticsearch-service-x86.exe  plugin.bat  
elasticsearch.bat            service.bat  
[Dharshekth-MacBook-Pro:bin dharshekthv]$ ./elasticsearch  
[2017-02-15 19:51:41,727][INFO ][node              ] [Screech] version[2.4.1], pid[2124], build[c67dc32/2016-09-27T18:57:55Z]  
[2017-02-15 19:51:41,729][INFO ][node              ] [Screech] initializing ...  
[2017-02-15 19:51:42,241][INFO ][plugins           ] [Screech] modules [reindex, lang-expression, lang-groovy], plugins [], sites []  
[2017-02-15 19:51:42,268][INFO ][env               ] [Screech] using [1] data paths, mounts [[(/dev/disk1)]], net usable_space [19.8gb], net total_space [232.6gb]  
b], spins? [unknown], types [hfs]  
[2017-02-15 19:51:42,268][INFO ][env               ] [Screech] heap size [989.8mb], compressed ordinary object pointers [true]  
[2017-02-15 19:51:42,269][WARN ][env               ] [Screech] max file descriptors [10240] for elasticsearch process likely too low, consider increasing to at least [65536]  
[2017-02-15 19:51:43,758][INFO ][node              ] [Screech] initialized  
[2017-02-15 19:51:43,758][INFO ][node              ] [Screech] starting ...  
[2017-02-15 19:51:43,825][INFO ][transport         ] [Screech] publish_address {127.0.0.1:9300}, bound_addresses {[fe80::1]:9300}, {[::]:9300}, {127.0.0.1:9300}  
[2017-02-15 19:51:43,830][INFO ][discovery        ] [Screech] elasticsearch/Q3QMOMSJQIOnCIGp2Xaufw  
[2017-02-15 19:51:46,872][INFO ][cluster.service  ] [Screech] new_master {Screech}{Q3QMOMSJQIOnCIGp2Xaufw}{127.0.0.1}{127.0.0.1:9300}, reason: zen-disco-join(elected_as_master, [0] joins received)  
[2017-02-15 19:51:46,888][INFO ][http              ] [Screech] publish_address {127.0.0.1:9200}, bound_addresses {[fe80::1]:9200}, {[::]:9200}, {127.0.0.1:9200}  
[2017-02-15 19:51:46,888][INFO ][node              ] [Screech] started  
[2017-02-15 19:51:46,900][INFO ][gateway          ] [Screech] recovered [0] indices into cluster_state  
[2017-02-15 19:52:16,889][WARN ][cluster.routing.allocation.decider] [Screech] high disk watermark [90%] exceeded on [Q3QMOMSJQIOnCIGp2Xaufw] [Screech] [/Users/dharshekthve/ac/elasticsearch241/data/elasticsearch/nodes/0] free: 19.8gb[8.5%], shards will be relocated away from this node  
[2017-02-15 19:52:16,889][INFO ][cluster.routing.allocation.decider] [Screech] rerouting shards: [high disk watermark exceeded on one or more nodes]  
[2017-02-15 19:52:46,900][WARN ][cluster.routing.allocation.decider] [Screech] high disk watermark [90%] exceeded on [Q3QMOMSJQIOnCIGp2Xaufw] [Screech] [/Users/dharshekthve/ac/elasticsearch241/data/elasticsearch/nodes/0] free: 19.8gb[8.5%], shards will be relocated away from this node  
[2017-02-15 19:53:16,904][WARN ][cluster.routing.allocation.decider] [Screech] high disk watermark [90%] exceeded on [Q3QMOMSJQIOnCIGp2Xaufw] [Screech] [/Users/dharshekthve/ac/elasticsearch241/data/elasticsearch/nodes/0] free: 19.8gb[8.5%], shards will be relocated away from this node  
[2017-02-15 19:53:16,904][INFO ][cluster.routing.allocation.decider] [Screech] rerouting shards: [high disk watermark exceeded on one or more nodes]  
[2017-02-15 19:53:46,910][WARN ][cluster.routing.allocation.decider] [Screech] high disk watermark [90%] exceeded on [Q3QMOMSJQIOnCIGp2Xaufw] [Screech] [/Users/dharshekthve/ac/elasticsearch241/data/elasticsearch/nodes/0] free: 19.8gb[8.5%], shards will be relocated away from this node  
[2017-02-15 19:54:16,915][WARN ][cluster.routing.allocation.decider] [Screech] high disk watermark [90%] exceeded on [Q3QMOMSJQIOnCIGp2Xaufw] [Screech] [/Users/dharshekthve/ac/elasticsearch241/data/elasticsearch/nodes/0] free: 19.8gb[8.5%], shards will be relocated away from this node  
[2017-02-15 19:54:16,915][INFO ][cluster.routing.allocation.decider] [Screech] rerouting shards: [high disk watermark exceeded on one or more nodes]  
[2017-02-15 19:54:46,919][WARN ][cluster.routing.allocation.decider] [Screech] high disk watermark [90%] exceeded on [Q3QMOMSJQIOnCIGp2Xaufw] [Screech] [/Users/dharshekthve/ac/elasticsearch241/data/elasticsearch/nodes/0] free: 19.8gb[8.5%], shards will be relocated away from this node  
[2017-02-15 19:55:16,920][WARN ][cluster.routing.allocation.decider] [Screech] high disk watermark [90%] exceeded on [Q3QMOMSJQIOnCIGp2Xaufw] [Screech] [/Users/dharshekthve/ac/elasticsearch241/data/elasticsearch/nodes/0] free: 19.8gb[8.5%], shards will be relocated away from this node  
[2017-02-15 19:55:16,920][INFO ][cluster.routing.allocation.decider] [Screech] rerouting shards: [high disk watermark exceeded on one or more nodes]
```



Elasticsearch Installation

Elastic Search starts on 9200 and when hit the port should return the below JSON

<http://localhost:9200/>

```
{  
  "status" : 200,  
  "name" : "Hydro",  
  "cluster_name" : "elasticsearch",  
  "version" : {  
    "number" : "1.7.2",  
    "build_hash" : "e43676b1385b8125d647f593f7202acbd816e8ec",  
    "build_timestamp" : "2015-09-14T09:49:53Z",  
    "build_snapshot" : false,  
    "lucene_version" : "4.10.4"  
  },  
  "tagline" : "You Know, for Search"  
}
```

Elastic Search Commands

To clear the cache. Here the logstash-gpuz is the index.

http://localhost:9200/logstash-gpuz*/_cache/clear

To get a list of all indexes

http://localhost:9200/_cat/indices?v

To refresh

http://localhost:9200/_refresh

Elastic Search Commands

To get the indices

```
$ curl http://localhost:9200/\_cat/indices?v
```

To delete an index

```
$ curl -XDELETE http://localhost:9200/uidai-\*
```

```
$ curl -XPUT 'http://localhost:9200/elephant-2015.12.02/_close'
```

```
$ curl -XPUT 'http://localhost:9200/elephant-2015.12.02/_settings' -d '{ "index" : {  
    "index.refresh_interval" : -1 } }'
```

```
$ curl -XPUT 'http://localhost:9200/elephant-2015.12.02/_open'
```

Elastic Search - Create Index

```
import requests  
  
# Create index  
  
url = 'http://localhost:9200/index102'  
response = requests.put(url)  
  
print response.text
```

To create a index, use the put API to put in the elastic search.

Elastic Search - Geo Index

```
{"mappings": {  
  "bank": {  
    "properties": {  
      "name": {  
        "type": "string"  
      },  
      "id": {  
        "type": "string"  
      },  
      "location": {  
        "type": "geo_point"  
      }  
    }  
  }  
}
```

The screenshot shows the Advanced REST client (ARC) interface. The left sidebar has 'ARC' selected. Under 'HTTP request', the method is set to 'POST' and the URL is 'http://localhost:9200/bexpress-geo/_geo'. The 'Headers form' tab is active, showing 'Content-Type: application/json'. The 'Raw payload' tab contains the JSON mapping provided in the code block above. The bottom status bar says 'Selected environment: default'.

```
POST http://localhost:9200/bexpress-geo/_geo  
Content-Type: application/json  
  
{"mappings": {  
  "bank": {  
    "properties": {  
      "name": {  
        "type": "string"  
      },  
      "id": {  
        "type": "string"  
      },  
      "location": {  
        "type": "geo_point"  
      }  
    }  
  }  
}
```

ElasticSearch - Geo Index

```
{  
  "banks": {  
    "properties": {  
      "name": {  
        "type": "string"  
      },  
      "id": {  
        "type": "string"  
      },  
      "location": {  
        "type": "geo_point"  
      }  
    }  
  }  
}
```

The screenshot shows the Advanced REST client (ARC) interface. The left sidebar has sections for 'Socket', 'History', 'Saved', and 'Projects'. The main area is titled 'Request' with the URL 'http://localhost:9200/bgeo/banks/_mapping'. The method is set to 'PUT'. The 'Headers form' tab is selected, showing 'Content-Type: application/json'. The 'Raw payload' tab is selected, displaying the JSON mapping definition. The bottom status bar says 'Selected environment: default'.

```
http://localhost:9200/bgeo/banks/_mapping  
PUT  
application/json  
Content-Type: application/json  
{  
  "banks": {  
    "properties": {  
      "name": {  
        "type": "string"  
      },  
      "id": {  
        "type": "string"  
      },  
      "location": {  
        "type": "geo_point"  
      }  
    }  
  }  
}
```

ElasticSearch - Geo Index

For the creation and population of GEO Index,

1. First create the index
2. Then create the mappings.
3. Then feed the data.

```
# Create index
```

```
url = 'http://localhost:9200/index102'  
response = requests.put(url)  
  
print response.text
```

ElasticSearch - Geo Index

For the creation and population of GEO Index,

1. First create the index
2. Then create the mappings.
3. Then feed the data.

Create the mapping for the geo-index

```
#To create a GEO INDEX

url = 'http://localhost:9200/index102/banks/_mapping'

data = """"

{
  "banks": {
    "properties": {
      "name": {
        "type": "string"
      },
      "id": {
        "type": "string"
      },
      "location": {
        "type": "geo_point"
      }
    }
  }
"""

response = requests.put(url, data=data)
print response.text
```

ElasticSearch - Geo Index

For the creation and population of GEO Index,

1. First create the index
2. Then create the mappings.
3. Then feed the data.

Feed the data

```
data = ""  
{  
    "name": "Goldman Sachs",  
    "location": {  
        "lat": 60.586967,  
        "lon": 15.422058  
  
    }  
}  
...  
  
range_of_counter = range(4000, 5000)  
  
for i in range_of_counter:  
    url = 'http://localhost:9200/index102/banks/%d?pretty' % i  
    response = requests.post(url, data=data)  
    print(" The response is - %s" % response.text)
```

Logstash Installation

Download Logstash from <https://www.elastic.co/downloads/logstash>

Download the logstash 1.5.4 from the above link and extract it.

Kibana Installation - Kibana 4.1.2

- [1] Download kibana from <https://www.elastic.co/downloads/kibana>
- [2] Extract the kibana-4.1.2-windows.zip file.
- [3] Go inside the *kibana/bin* directory and run the *kibana.bat* to start kibana.
- [4] Kibana should start by default in port 5601. You should be able to knock <http://localhost:5601/> and kibana should be up and running.

Kibana Installation - Kibana 4.1.2

```
D:\kibana412>cd bin
D:\kibana412\bin>dir
 Volume in drive D has no label.
 Volume Serial Number is 264F-D60B

 Directory of D:\kibana412\bin

09/08/2015  01:12 PM    <DIR>
09/08/2015  01:12 PM    <DIR>
09/08/2015  01:12 PM                540 kibana
09/08/2015  01:12 PM            295 kibana.bat
              2 File(s)           835 bytes
              2 Dir(s)  49,435,271,168 bytes free

D:\kibana412\bin>kibana.bat
{"name":"Kibana","hostname":"240.002720-LT33","pid":6376,"level":30,"msg":"No existing kibana index found","time":"2015-10-13T09:49:47.679Z","v":0}
{"name":"Kibana","hostname":"240.002720-LT33","pid":6376,"level":30,"msg":"Listing on 0.0.0.0:5601","time":"2015-10-13T09:49:47.753Z","v":0}
```

The screenshot shows the Kibana Settings page at [localhost:5601/#/settings/indices/_g\(\)](http://localhost:5601/#/settings/indices/_g()). The top navigation bar includes links for Discover, Visualize, Dashboard, and Settings. The main content area is titled "Configure an index pattern". A warning message states: "Warning No default index pattern. You must select or create one to continue." Below this, a note says: "In order to use Kibana you must configure at least one index pattern. Index patterns are used to identify the Elasticsearch index to run search and analytics against. To configure fields." There are two checkboxes at the bottom: "Index contains time-based events" (checked) and "Use event times to create index names".

localhost:5601/#/settings/indices/_g()

kibana

Discover Visualize Dashboard Settings

Indices Advanced Objects About

Index Patterns

Warning No default index pattern.
You must select or create one to continue.

Configure an index pattern

In order to use Kibana you must configure at least one index pattern. Index patterns are used to identify the Elasticsearch index to run search and analytics against. To configure fields.

Index contains time-based events

Use event times to create index names

Kibana Installation - Kibana 4.1.2

The screenshot shows two parts of the Elasticsearch interface. The top part is a browser window displaying the command `localhost:9200/_cat/indices?v`, which lists indices: .kibana, uidai-auth-alpha-2015.10.29, and uidai-auth-alpha-2015.10.28. An orange arrow points from this URL to a yellow box containing the text: "All the list of indices can be obtained from the elastic search URL". The bottom part is the Kibana configuration interface at `localhost:5601/#/settings/indices/?_g=(filters:!((meta:(disabled:!f,index:'uidai-auth-alpha*',key:error_code_events.count,negate:!f,value:'123')))`. It shows an index pattern named "uidai-auth-alpha*". A red arrow points from the "Index name or pattern" input field, which contains "logstash-*", to a yellow box containing the text: "Give the proper index name".

health status index pri rep docs.count docs.deleted indexed store.size pri.store.size
yellow open .kibana 1 1 10 1 50.1kb 50.1kb
yellow open uidai-auth-alpha-2015.10.29 5 1 791 0 2.4mb 2.4mb
yellow open uidai-auth-alpha-2015.10.28 5 1 6049 0 9.7mb 9.7mb

All the list of indices can be obtained from the elastic search URL

localhost:5601/#/settings/indices/?_g=(filters:!((meta:(disabled:!f,index:'uidai-auth-alpha*',key:error_code_events.count,negate:!f,value:'123')))

kibana

Discover Visualize Dashboard Settings

Indices Advanced Objects About

Index Patterns

★ uidai-auth-alpha*

Configure an index pattern

In order to use Kibana you must configure at least one index pattern. Index patterns are used to identify the Elasticsearch index to run search and analytics against.

Index contains time-based events
 Use event times to create index names

Index name or pattern

Patterns allow you to define dynamic index names using * as a wildcard. Example: logstash-*

logstash-*

Unable to fetch mapping. Do you have indices matching the pattern?

Give the proper index name

Logstash and ElasticSearch Connection

To check on whether the input.conf is in coherent to the standard use the below command. The below command would parse the input.conf and show the parsing result. The below --configtest is just a configuration test.

```
D:\logstash154\bin>logstash.bat -f D:/input.conf --configtest
```

Start the log stash by using the below command.

```
D:\logstash154\bin>logstash.bat -f input.conf
```

The input.conf should be in the bin folder and would look like as shown below. The input is a file log and the output is fed to the elastic search.

```
input {  
    stdin {}  
    file { path => "D:/log001.txt" }  
}  
output {  
    stdout {}  
    elasticsearch_http { host => "localhost" index => "logstash-gpuz-%{+YYYY.MM.dd}" }  
}
```

Logstash filter - hello world

A simple filter using grok

```
2015-10-14 11:06:51,205 ["http-bio-9000"-exec-2] INFO [authcommon.helpers.Auditor] - Time taken to save Hbase Audit Write is: 14 ms
2015-10-14 11:06:51,205 ["http-bio-9000"-exec-2] INFO [authcommon.helpers.NotificationConstructor] - ** No email or phone for notification purposes. Skipping notification for 2bd8e85e90da4a879372ef323ba443ce
2015-10-14 11:06:51,213 ["http-bio-9000"-exec-2] INFO [impl.messaging.RabbitMQMessagePublisherImpl] - Message of count index : 21 published into queue : genericBiNotificationQueue
2015-10-14 11:06:51,214 ["http-bio-9000"-exec-2] INFO [authcommon.helpers.Auditor] - Time taken to publish in BI notification queue:8 ms
2015-10-14 11:06:51,214 ["http-bio-9000"-exec-2] INFO [web.rest.AuthenticationResource] - Total Auth Response Time: 304 ms
```

```
filter {
  grok {
    match => { "message" => "%{TIMESTAMP_ISO8601:stamp} \[" %{GREEDYDATA:message}" }
    add_tag => "to_%{message}"
  }
}
```

Logstash filter - csv

```
filter {
    csv {
        columns => ["auth_code","subreq_id","aua","sa","asa","ver"]
        separator => ","
    }
    mutate {
        convert => {"asa" => "integer"}
    }
}
```

Logstash

grok() - grok converts unstructured data to structured data.

Elasticsearch Delete

The screenshot shows the Advanced Rest Client interface. A red box labeled '1' highlights the URL input field containing 'http://localhost:9200/_idai-*'. Another red box labeled '2' highlights the 'DELETE' button in the method selection row. A third red box labeled '3' highlights the 'Send' button at the bottom right.

Advanced Rest Client [Unnamed]

Request Method: DELETE GET POST PUT PATCH HEAD OPTIONS Other

Socket Projects Saved History Settings About

Raw Form Headers

Raw Form Files (0) Payload

Encode payload Decode payload

application/x-www-form-urlencoded Set "Content-Type" header to overwrite this value.

Clear Send

Status 200 OK Loading time: 262 ms

Request headers

User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/46.0.2490.71 Safari/537.36
Origin: chrome-extension://hgmloofddfdnphgcellkdfbjeloo
Content-Type: application/x-www-form-urlencoded
Accept: */*
Accept-Encoding: gzip, deflate, sdch
Accept-Language: en-US,en;q=0.8

Performance Tuning in ELK Stack

Fine tune your elastic search
memory components

In the
`/elasticsearch/bin/elasticsearch.in.sh`
file set the **ES_MIN_MEM** and
ES_MAX_MEM values to an optimal
level. **ES_MAX_MEM** can have a
60% of your RAM.

```
#!/bin/sh

# check in case a user was using this mechanism
if [ "x$ES_CLASSPATH" != "x" ]; then
    cat >&2 << EOF
Error: Don't modify the classpath with ES_CLASSPATH. Best is to add
additional elements via the plugin mechanism, or if code must really be
added to the main classpath, add jars to lib/ (unsupported).
EOF
    exit 1
fi

ES_CLASSPATH="$ES_HOME/lib/elasticsearch-2.0.0.jar:$ES_HOME/lib/*"

if [ "x$ES_MIN_MEM" = "x" ]; then
    ES_MIN_MEM=5g
fi
if [ "x$ES_MAX_MEM" = "x" ]; then
    ES_MAX_MEM=70g
fi
if [ "x$ES_HEAP_SIZE" != "x" ]; then
    ES_MIN_MEM=$ES_HEAP_SIZE
    ES_MAX_MEM=$ES_HEAP_SIZE
fi

# min and max heap sizes should be set to the same value to avoid
# stop-the-world GC pauses during resize, and so that we can lock the
# heap in memory on startup to prevent any of it from being swapped
# out.
JAVA_OPTS="$JAVA_OPTS -Xms${ES_MIN_MEM}"
JAVA_OPTS="$JAVA_OPTS -Xmx${ES_MAX_MEM}"
```

Performance Tuning in ELK Stack

Fine tune your elastic search
memory components

Set the heap size of the elastic search to 60% of your memory. In order to set the heap size, set the value to the ES_HEAP_SIZE variable.

```
$ export ES_HEAP_SIZE=80g
```

Performance Tuning in ELK Stack

When starting logstash
specify the number of cores of
your CPU's using the -w

```
$ logstash -w 24 -f input.conf
```

X-Pack

X-Pack is an elastic extension that bundles security, alerting, monitoring, reporting and graph capabilities.

To install x-pack execute the below command:

```
$ bin/elasticsearch-plugin install x-pack
```



chinna samyad@gmail.com

Apache Solr

Apache Solr is the open source enterprise search platform built on top of Apache Lucene.

Latest Version - 5.4

Apache Solr

Hibernate Search,
Solr,
Elastic Search all form the inverted search index on top of
lucene library.

Solr - Start the server.

To start the server, go to bin folder and give `$ solr start`

`$ solr_installation/bin/ solr start`

The screenshot shows a Windows Command Prompt window titled 'C:\Windows\system32\cmd.exe'. The window displays the output of a 'dir' command run from the directory 'C:\solr541\bin'. The output lists several files and directories, including 'install_solr_service.sh', 'oom_solr.sh', 'post', 'solr', 'solr.cmd', 'solr.in.cmd', 'solr.in.sh', and 'solr.in.sh'. It also shows the total size of the files and the free disk space. At the bottom of the window, the command '`>solr start`' is typed into the prompt, followed by the output of the command: 'Waiting up to 30 to see Solr running on port 8983' and 'Started Solr server on port 8983. Happy searching!'. The entire window is contained within a red rectangular border.

```
C:\solr541\bin>dir
Volume in drive C has no label.
Volume Serial Number is 14BC-5505

Directory of C:\solr541\bin

19-02-2016  11:11    <DIR>
19-02-2016  11:11    <DIR>
19-02-2016  11:11    <DIR>          init.d
19-02-2016  11:11            10,647 install_solr_service.sh
19-02-2016  11:11            1,255 oom_solr.sh
19-02-2016  11:11            7,754 post
19-02-2016  11:11            47,969 solr
19-02-2016  11:11            43,203 solr.cmd
19-02-2016  11:11            4,487 solr.in.cmd
19-02-2016  11:11            4,953 solr.in.sh
                           ? File(s)      120,268 bytes
                           3 Dir(s)   653,920,395,264 bytes free

C:\solr541\bin>>solr start
Waiting up to 30 to see Solr running on port 8983
Started Solr server on port 8983. Happy searching!
C:\solr541\bin>
```

Solr - Start the server.

After you issue the command, solr start, solr by default starts in 8983 port.

Hit on <http://localhost:8983/solr/#/> to see the admin UI of the solr start.



Dashboard

Logging

Core Admin

Java Properties

Thread Dump

No cores available

Go and create one

Instance

Start 6 minutes ago

Versions

solr-spec	5.4.1
solr-impl	5.4.1 1725212 - jpountz - 2016-01-18 11:51:45
lucene-spec	5.4.1
lucene-impl	5.4.1 1725212 - jpountz - 2016-01-18 11:44:59

JVM

Runtime	Oracle Corporation Java HotSpot(TM) 64-Bit Server VM (1.8.0_60 25.60-b23)
Processors	4
Args	<pre>-DSTOP.KEY=solrrocks -DSTOP.PORT=7983 -Djava.io.tmpdir=C:\solr541\server\tmp -Djetty.home=C:\solr541\server -Djetty.port=8983 -Dlog4j.configuration=file:C:\solr541\server\resources\log4j.properties -Dsolr.install.dir=C:\solr541 -Dsolr.solr.home=C:\solr541\server\solr -Duser.timezone=UTC -XX:+CMSParallelRemarkEnabled -XX:+CMSScavengeBeforeRemark -XX:+ParallelRefProcEnabled</pre>

System

Physical Memory 72.2%

Swap Space 37.1%

JVM-Memory 15.1%



Create a document collection

```
C:\solr541\bin>solr create -c uidai-demographic
```

Copying configuration to new core instance directory:

```
C:\solr541\server\solr\uidai-demographic
```

Creating new core 'uidai-demographic' using command:

```
http://localhost:8983/solr/admin/cores?action=CREATE&name=uidai-demographic&instanceDir=uidai-demographic
```

```
{
  "responseHeader":{
    "status":0,
    "QTime":2512},
  "core":"uidai-demographic"}
```

Create a document collection

```
C:\solr541\bin>solr create -c uidai-demographic
```

Copying configuration to new core instance directory:

```
C:\solr541\server\solr\uidai-demographic
```

Creating new core 'uidai-demographic' using command:

```
http://localhost:8983/solr/admin/cores?action=CREATE&name=uidai-demographic&instanceDir=uidai-demographic
```

```
{
  "responseHeader":{
    "status":0,
    "QTime":2512},
  "core":"uidai-demographic"}
```

Write document to Solr

```
HttpSolrClient client = new HttpSolrClient("http://localhost:8983/solr/uidai-demographic");
```

```
SolrInputDocument input = new SolrInputDocument();
input.addField( "uid", "764567345689");
input.addField( "address", "rnnpuram");
input.addField( "state", "tamil nadu" );
```

```
Collection<SolrInputDocument> docs = new ArrayList<SolrInputDocument>();
docs.add(input);
```

```
try {
    client.add(docs);
    client.commit();
    client.close();
} catch (SolrServerException | IOException e) {
    System.out.println(e.getMessage());
}
```

Write document to Solr

```
import org.apache.solr.client.solrj.SolrQuery;  
import org.apache.solr.client.solrj.SolrServerException;  
import org.apache.solr.client.solrj.impl.HttpSolrClient;  
import org.apache.solr.client.solrj.response.QueryResponse;  
import org.apache.solr.common.SolrDocumentList;  
import org.apache.solr.common.SolrInputDocument;
```

Write document to Solr

```
import org.apache.solr.client.solrj.SolrQuery;  
import org.apache.solr.client.solrj.SolrServerException;  
import org.apache.solr.client.solrj.impl.HttpSolrClient;  
import org.apache.solr.client.solrj.response.QueryResponse;  
import org.apache.solr.common.SolrDocumentList;  
import org.apache.solr.common.SolrInputDocument;
```

Querying on to Solr

```
HttpSolrClient client = new HttpSolrClient("http://localhost:8983/solr/uidai-demographic");

SolrQuery query = new SolrQuery();
query.setQuery("uid=764567345689");

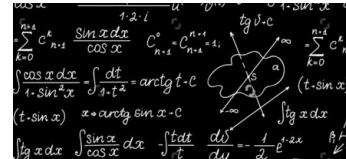
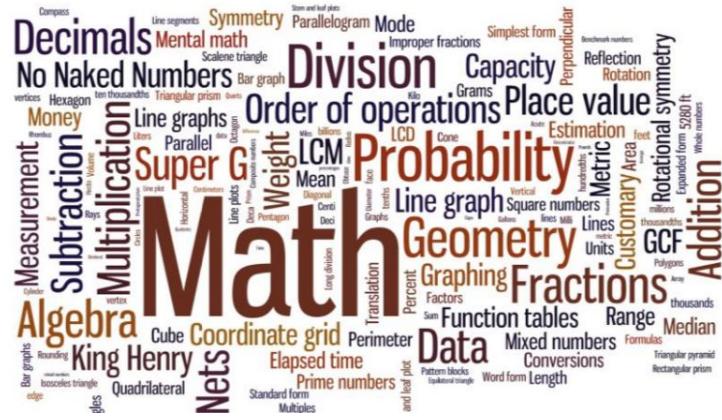
query.setFields("uid","address","state");
    query.setStart(0);
    query.set("defType", "edismax");
try {
    QueryResponse response = client.query(query);
    SolrDocumentList results = response.getResults();

    System.out.println(results.size());
    for (int i = 0; i < results.size(); ++i) {
        System.out.println(results.get(i).getFieldValue("state"));
    }

    client.close();
} catch (SolrServerException | IOException e) {
    e.printStackTrace();
}
```

Inverted Index

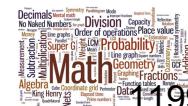
Solr search works on the principle of inverted index data structure.



Machine Learning

$y = \frac{(x-16)}{(x^2+38)}$ $a \operatorname{sh} x = \frac{2t}{1-t^2}$
 $-89.9e^{-t+1.2} \quad (-1 < t < 1)$
 $\operatorname{OS} \alpha = 45^\circ - \cos \beta = 89^\circ = \sin \alpha \cdot \beta$
 $\sum_{n=0}^{\infty} \frac{(z-z_0)^n}{(t-z_0)^{n+1}} C_{n+1}^0 C_{n+1}^{n+1} y^n$
 $dx = \frac{2dt}{1-t^2}, \quad \frac{1}{\cos(u/2)}$
 $\sum_{n=0}^{\infty} C_n^1$

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Supervised Learning

Supervised is by which the model is rendered by the data in hand.

Decision Tree

Various algorithms used in the decision tree are:

Gini : Formulated by Corrado Gini.

Entropy

Chi Square

Reduction of Variance

DBScan

DBScan for anomaly detection.

DBScan with gower's distance calculation performs much better in the anomaly detection.

Neural Networks

A machine learning algorithm for predicting based on existing data set.

Neural Networks - Single Neuron

Neural Networks - Multiple Neurons and Neural Network architecture

Natural Language Processing

NLP

Nltk.org

In the python prompt,

```
>> import nltk  
>> nltk.download()
```

Will start the downloader of the nltk data.

The NLTK Downloader application window is shown. It has a tab bar at the top with 'Collections' (selected), 'Corpora', 'Models', and 'All Packages'. Below the tabs is a table with four columns: 'Identifier', 'Name', 'Size', and 'Status'. The table contains three rows:

Identifier	Name	Size	Status
all	All packages	n/a	partial
all-corpora	All the corpora	n/a	partial
book	Everything used in the NLTK Book	n/a	partial

At the bottom of the window, there are buttons for 'Cancel' and 'Refresh'. Below the buttons, there are two input fields: 'Server Index:' containing the URL https://raw.githubusercontent.com/nltk/nltk_data/gh-pages/index.xml and 'Download Directory:' containing the path '/Users/dharshekthvel/nltk_data'. A progress bar at the bottom indicates the download status of the package 'unicode_samples'.



Gensim is a good NLP tool for finding similarity between phrases and documents

<https://radimrehurek.com/gensim/tut3.html>

GATE

General Architecture for Text Engineering

Names are a { bag of words } in GATE.

To add a list of names, add the names to the following lst file.

`/home/dharshekthvel/ac/code/ResumeParser-master/GATEFiles/plugins/ANNIE/resources/gazetteer/person_male.lst`

To add a list of months, add to the following file

`/home/dharshekthvel/ac/code/ResumeParser-master/GATEFiles/plugins/ANNIE/resources/gazetteer/months.lst`

To add Organizations, add to the below place holder

`/home/dharshekthvel/ac/code/ResumeParser-master/GATEFiles/plugins/ANNIE/resources/gazetteer/organization.lst`

ANNIE

Tokenizer => Sentence Splitter => POS Tagger => Gazetteer => JAPE Transducer

Tokenizer: Splits the text into tokens such as numbers, punctuation, words.

Sentence Splitter: Segments the text into sentences. This phase is needed for POS tagging.

POS tagger: This phase produces a parts-of-speech tag as an annotation to each word.

Gazetteer: The Gazetteer list is the lookup of the entities. The list is stored in various files.

JAPE - Java Annotation Patterns Engine

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Twitter



Twitter Apps

Please [sign in](#) with your Twitter Account to create and maintain Twitter Apps.

Goto <https://apps.twitter.com>





Create an application

Application Details

Name *

Your application name. This is used to attribute the source of a tweet and in user-facing authorization screens. 32 characters max.

Description *

Your application description, which will be shown in user-facing authorization screens. Between 10 and 200 characters max.

Website *

Your application's publicly accessible home page, where users can go to download, make use of, or find out more information about your application. This fully-qualified URL is used in the source attribution for tweets created by your application and will be shown in user-facing authorization screens.
(If you don't have a URL yet, just put a placeholder here but remember to change it later.)

Callback URL

Where should we return after successfully authenticating? OAuth 1.0a applications should explicitly specify their oauth_callback URL on the request token step, regardless of the value given here. To restrict your application from using callbacks, leave this field blank.

Developer Agreement

Yes, I have read and agree to the [Twitter Developer Agreement](#).

Create an application

Application Details

Name *

Your application name. This is used to attribute the source of a tweet and in user-facing authorization screens. 32 characters max.

Description *

Your application description, which will be shown in user-facing authorization screens. Between 10 and 200 characters max.

Website *

Your application's publicly accessible home page, where users can go to download, make use of, or find out more information about your application. This fully-qualified URL is used in the source attribution for tweets created by your application and will be shown in user-facing authorization screens.
(If you don't have a URL yet, just put a placeholder here but remember to change it later.)

Callback URL

Where should we return after successfully authenticating? [OAuth 1.0a](#) applications should explicitly specify their oauth_callback URL on the request token step, regardless of the value given here. To restrict your application from using callbacks, leave this field blank.

Developer Agreement

Yes, I have read and agree to the [Twitter Developer Agreement](#).



HThreeSixty

[Test OAuth](#)

Details

Settings

Keys and Access Tokens

Permissions



HThreeSixty_Project

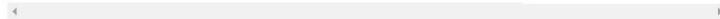
<http://yahoo.com>

Organization

Information about the organization or company associated with your application. This information is optional.

Organization None

Organization website None



Application Settings

Your application's Consumer Key and Secret are used to [authenticate](#) requests to the Twitter Platform.

Access level Read and write ([modify app permissions](#))

Consumer Key (API Key) H7gCcVkw7HI8C4hbgEo62h6zF ([manage keys and access tokens](#))

Callback URL None

Callback URL Locked No

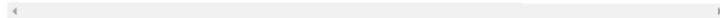
Sign in with Twitter Yes

App-only authentication <https://api.twitter.com/oauth2/token>

Request token URL https://api.twitter.com/oauth/request_token

Authorize URL <https://api.twitter.com/oauth/authorize>

Access token URL https://api.twitter.com/oauth/access_token



Application Settings

Keep the "Consumer Secret" a secret. This key should never be human-readable in your application.

Consumer Key (API Key) H7gCcVkw7Hl8C4hbgEo62h6zF

Consumer Secret (API Secret) yGgJ8lT5FKoNcrMWCE31tmQqtKzPiSnhiX9XuXlFP4P54XVdxg

Access Level Read and write ([modify app permissions](#))

Owner chinnasamydhara

Owner ID 837928192170209280

Application Actions

[Regenerate Consumer Key and Secret](#)

[Change App Permissions](#)

Your Access Token

This access token can be used to make API requests on your own account's behalf. Do not share your access token secret with anyone.

Access Token 837928192170209280-vOp7XGPdehsV0VSTouN6YisQReaEQGt

Access Token Secret 6HnqRgWUyQWPSUfKKpthSP7jXUBFfU7hVop6vlfJxUQpL

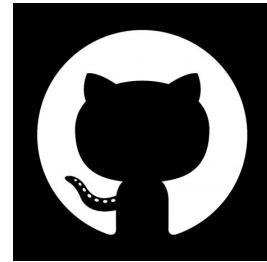
Access Level Read and write

Owner chinnasamydhara

Owner ID 837928192170209280

Create your access token and you should have
your access tokens.





github

Common git commands

```
$ git clone <<git_repository>>
```



Common git commands

```
$ git diff HEAD --name-only
```

```
$ git branch spark-scala-branch
```

```
$ git checkout spark-scala-branch
```

```
$ git pull
```

```
$ git commit -m "Comments" full/path/to/file/file.scala
```

```
$ git push -u origin spark-scala-branch
```

```
// To push directly to master
```

```
$ git push origin master
```

chinnasamyad@gmail.com



Common git commands

Add all files and commit all files

```
$ git add -A && git commit -m "Message"
```



Videos

<https://github.com/achinnasamy/videos>

1. *roadshow_news.mp4*: The video contains news feeds of RSS parsed and written to elastic search and kibana is visualization of the elastic search to a data table. Tech: Kibana (Data Table), Elastic Search, Java, RSS Feed Parsing.
2. *roadshow_twitter.mkv*: The video contains a Spark streaming hitting twitter and taking twitter feeds and ingesting to elastic search. Kibana visualization with various graphs with a Dashboard is performed on the elastic search index. Tech: Kibana, Spark Twitter Streaming, Elastic Search, Many visualization graphs on Kibana.
3. [HDFS_Installation_Configuring.mkv](#) The video contains, setting up of hdfs in a single node cluster. All issues that you encounter in a setup is shown in the video.





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Add java to your classpath

[1] *Setting up PATH in environment, so that it is available every time when a PC starts:*

In linux, to add java to your path goto \$ /etc/environment and java bin folder to it.

```
PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/home/dharshekthvel/ac/bin/jdk8  
/bin"
```

[2] *Setting up JAVA_HOME in profile:*

Also add the following entry to /etc/profile

```
export JAVA_HOME=/home/dharshekthvel/ac/bin/jdk8
```

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

To find the complete list of files containing the word ordinal, use the below command.

```
$ grep -rnw '/home/dharshekthvel/ac/code' -e "ordinal"
```

Check what all hadoop process is running

```
$ ps -ef | grep hadoop
```

Check what linux you are running

```
$ uname -a
```

```
$ lsb_release -a
```

To get the info of the complete hardware in MAC:

```
$ system_profiler SPHardwareDataType
```

To get the no of cores of the CPU:

In linux:

```
$ lscpu
```

Or

```
$ sysctl --all | grep cpu
```

In mac:

```
$ sysctl -n hw.cpu
```

```
$ sysctl -a | grep cpu
```

To get the no of cores of the CPU:

In linux:

```
$ lscpu
```

CPU(s): 8

On-line CPU(s) list: 0-7

Thread(s) per core: 2

Core(s) per socket: 4

Socket(s): 1

The CPU depicts the number of threads.

CPU(s): 8

Total number of threads is = CPU(s): which is 8

which is calculated using CPU(s): Thread(s) per core x Core(s) per socket x Socket(s) which is $2 \times 4 \times 1 = 8$ which is nothing by CPU(s)

Netcat utility

Producer and consumer using netcat utility.

```
$ nc 127.0.0.1 4567
```

The above command sends data to 4567.

```
$ nc -l 4567
```

The above command receives data from port 4567





Setting up ambari server

1. Log in to your host as root.
2. wget -nv http://public-repo-1.hortonworks.com/ambari/ubuntu14/2.x/updates/2.4.2.0/ambari.list -O /etc/apt/sources.list.d/ambari.list
3. apt-key adv --recv-keys --keyserver keyserver.ubuntu.com B9733A7A07513CAD
4. apt-get update
5. Confirm whether the ambari server installation is present.
 apt-cache showpkg ambari-server
 apt-cache showpkg ambari-agent
 apt-cache showpkg ambari-metrics-assembly
6. Install the ambari server
 apt-get install ambari-server

Setting up ambari server

7. \$ ambari-server setup
8. \$ ambari-server start

Install ambari agent on each of the hosts.

9. \$ sudo apt-get install ambari-agent

For change in the config of ambari-agent, change the below config file.
vi /etc/ambari-agent/conf/ambari-agent.ini

Then start the ambari agent:

\$ ambari-agent start

Big Data - Google 1. Log in to Apache Ambari stanford nlp find online proxy brows New Tab

localhost:8080/#/login

Ambari

Sign in

Username
admin

Password

Sign in

Big Data - Google ▾ 1. Log In to Apache ▾ Ambari - Cluster Installs ▾ standford nlp find ▾ online proxy browser ▾ New Tab

localhost:8080/#/installer/step0

Ambari

admin

CLUSTER INSTALL WIZARD

Get Started

Select Version

Install Options

Confirm Hosts

Choose Services

Assign Masters

Assign Slaves and Clients

Customize Services

Review

Install, Start and Test

Summary

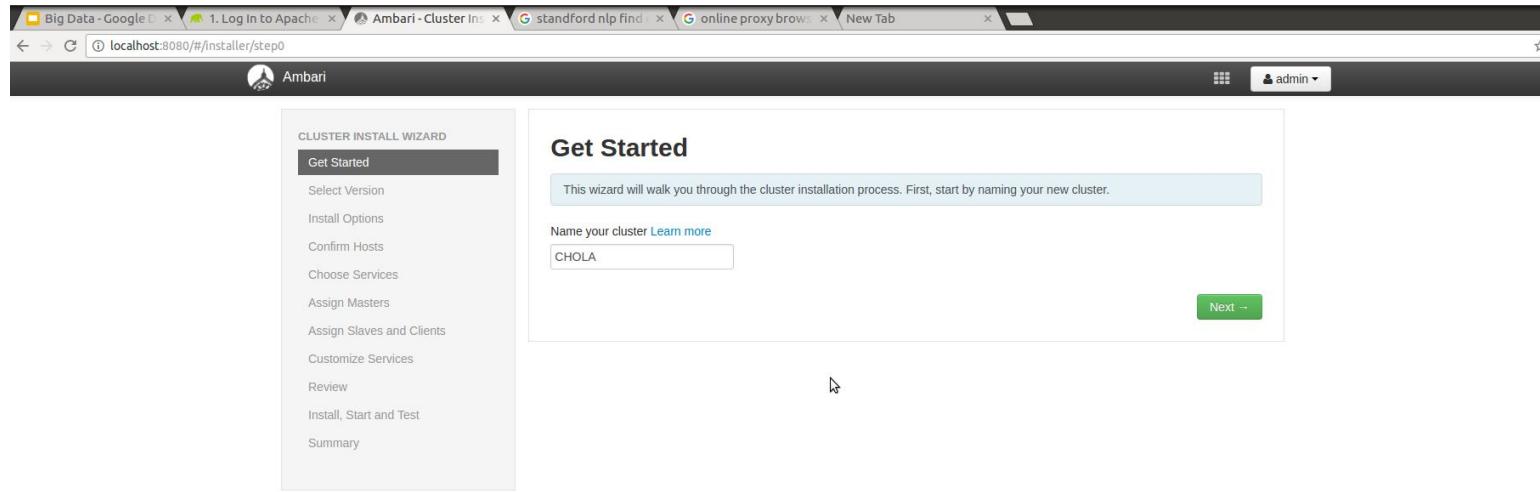
Get Started

This wizard will walk you through the cluster installation process. First, start by naming your new cluster.

Name your cluster [Learn more](#)

CHOLA

Next →



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Big Data - Google | 1. Log In to Apache | Ambari - Cluster In... | standford nlp find | Google online proxy browser | New Tab

localhost:8080/#/installer/step2

Ambari

admin

CLUSTER INSTALL WIZARD

Get Started

Select Version

Install Options

Confirm Hosts

Choose Services

Assign Masters

Assign Slaves and Clients

Customize Services

Review

Install, Start and Test

Summary

Install Options

Enter the list of hosts to be included in the cluster and provide your SSH key.

Target Hosts

Enter a list of hosts using the Fully Qualified Domain Name (FQDN), one per line. Or use Pattern Expressions

host names

Host Registration Information

Provide your [SSH Private Key](#) to automatically register hosts

[Choose file](#) No file chosen

ssh private key

SSH User Account

SSH Port Number

Perform [manual registration](#) on hosts and do not use SSH

[Back](#) [Register and Confirm](#)

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localhost:8080/#/installer/step3

Ambari

admin

CLUSTER INSTALL WIZARD

- Get Started
- Select Version
- Install Options
- Confirm Hosts**
- Choose Services
- Assign Masters
- Assign Slaves and Clients
- Customize Services
- Review
- Install, Start and Test
- Summary

Confirm Hosts

Registering your hosts.
Please confirm the host list and remove any hosts that you do not want to include in the cluster.

Show:	All (1)	Installing (0)	Registering (1)	Success (0)	Fail (0)
Host	Progress	Status	Action		
localhost	<div style="width: 100%;"> </div>	Registering	<input type="button" value="Remove"/>		

Show: 25 ▾ 1 - 1 of 1 ⏪ ⏩ ⏴ ⏵

Back Next



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Big Data - Google ... × G hortonworks - Go... × M Inbox (1,440) - chin... × Ambari - Cluster In... × 2. Install the Ambari ...

localhost:8080/#/installer/step3

Ambari

admin

CLUSTER INSTALL WIZARD

- Get Started
- Select Version
- Install Options
- Confirm Hosts**
- Choose Services
- Assign Masters
- Assign Slaves and Clients
- Customize Services
- Review
- Install, Start and Test
- Summary

Confirm Hosts

Registering your hosts.
Please confirm the host list and remove any hosts that you do not want to include in the cluster.

	Host	Progress	Status	Action
<input type="checkbox"/>	dharshekthvel	<div style="width: 100%;"> </div>	Success	Remove

Show: All (1) | Installing (0) | Registering (0) | Success (1) | Fail (0)

Show: 25 ▾ 1 - 1 of 1 ⌂ ⌃ ⌁ ⌄ ⌅ ⌆ ⌇ ⌈ ⌉

Please wait while the hosts are being checked for potential problems...

Back Next

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Big Data - Google | hortonworks - Go | M Inbox (1,440) - chin | Ambari - Cluster Info | 2. Install the Ambari

localhost:8080/#/installer/step4

Ambari

admin

CLUSTER INSTALL WIZARD

Get Started

Select Version

Install Options

Confirm Hosts

Choose Services

Assign Masters

Assign Slaves and Clients

Customize Services

Review

Install, Start and Test

Summary

Choose Services

Choose which services you want to install on your cluster.

Service	Version	Description
<input checked="" type="checkbox"/> HDFS	2.7.3	Apache Hadoop Distributed File System
<input checked="" type="checkbox"/> YARN + MapReduce2	2.7.3	Apache Hadoop NextGen MapReduce (YARN)
<input checked="" type="checkbox"/> Tez	0.7.0	Tez is the next generation Hadoop Query Processing framework written on top of YARN.
<input checked="" type="checkbox"/> Hive	1.2.1000	Data warehouse system for ad-hoc queries & analysis of large datasets and table & storage management service
<input checked="" type="checkbox"/> HBase	1.1.2	A Non-relational distributed database, plus Phoenix, a high performance SQL layer for low latency applications.
<input checked="" type="checkbox"/> Pig	0.16.0	Scripting platform for analyzing large datasets
<input checked="" type="checkbox"/> Sqoop	1.4.6	Tool for transferring bulk data between Apache Hadoop and structured data stores such as relational databases
<input checked="" type="checkbox"/> Oozie	4.2.0	System for workflow coordination and execution of Apache Hadoop jobs. This also includes the installation of the optional Oozie Web Console which relies on and will install the ExtJS Library.
<input checked="" type="checkbox"/> ZooKeeper	3.4.6	Centralized service which provides highly reliable distributed coordination
<input checked="" type="checkbox"/> Falcon	0.10.0	Data management and processing platform
<input checked="" type="checkbox"/> Storm	1.0.1	Apache Hadoop Stream processing framework
<input checked="" type="checkbox"/> Flume	1.5.2	A distributed service for collecting, aggregating, and moving large amounts of streaming data into HDFS
<input checked="" type="checkbox"/> Accumulo	1.7.0	Robust, scalable, high performance distributed key/value store.
<input checked="" type="checkbox"/> Ambari Infra	0.1.0	Core shared service used by Ambari managed components.
<input checked="" type="checkbox"/> Ambari Metrics	0.1.0	A system for metrics collection that provides storage and retrieval capability for metrics collected from the cluster
<input checked="" type="checkbox"/> Atlas	0.7.0	Atlas Metadata and Governance platform

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localhost:8080/#installer/step5

Ambari

admin

CLUSTER INSTALL WIZARD

Get Started

Select Version

Install Options

Confirm Hosts

Choose Services

Assign Masters

Assign Slaves and Clients

Customize Services

Review

Install, Start and Test

Summary

Assign Masters

Assign master components to hosts you want to run them on.

* HiveServer2 and WebHCat Server will be hosted on the same host.

SNameNode: dharshkthvel (15.5 GB, 8 cores)

NameNode: dharshkthvel (15.5 GB, 8 cores)

ResourceManager: dharshkthvel (15.5 GB, 8 cores)

App Timeline Server: dharshkthvel (15.5 GB, 8 cores)

History Server: dharshkthvel (15.5 GB, 8 cores)

Hive Metastore: dharshkthvel (15.5 GB, 8 cores)

WebHCat Server: dharshkthvel*

HiveServer2: dharshkthvel (15.5 GB, 8 cores)

HBase Master: dharshkthvel (15.5 GB, 8 cores)

Oozie Server: dharshkthvel (15.5 GB, 8 cores)

ZooKeeper Server: dharshkthvel (15.5 GB, 8 cores)

Falcon Server: dharshkthvel (15.5 GB, 8 cores)

Nimbus: dharshkthvel (15.5 GB, 8 cores)

DRPC Server: dharshkthvel (15.5 GB, 8 cores)

Storm UI Server: dharshkthvel (15.5 GB, 8 cores)

Accumulo GC: dharshkthvel (15.5 GB, 8 cores)

dharshkthvel (15.5 GB, 8 cores)

SNameNode NameNode ResourceManager

App Timeline Server History Server

Hive Metastore WebHCat Server

HiveServer2 HBase Master Oozie Server

ZooKeeper Server Falcon Server Nimbus

DRPC Server Storm UI Server Accumulo GC

Accumulo Monitor Accumulo Tracer

Accumulo Master Infra Solr Instance

Grafana Metrics Collector

Atlas Metadata Server Kafka Broker

Knox Gateway Log Search Server

Activity Analyzer Activity Explorer

HST Server Spark History Server

Spark2 History Server Zeppelin Notebook

Assign Masters

Assign master components to hosts you want to run them on.

* HiveServer2 and WebHCat Server will be hosted on the same host.

SNameNode: dharshkthvel (15.5 GB, 8 cores)

NameNode: dharshkthvel (15.5 GB, 8 cores)

ResourceManager: dharshkthvel (15.5 GB, 8 cores)

App Timeline Server: dharshkthvel (15.5 GB, 8 cores)

History Server: dharshkthvel (15.5 GB, 8 cores)

Hive Metastore: dharshkthvel (15.5 GB, 8 cores)

WebHCat Server: dharshkthvel*

HiveServer2: dharshkthvel (15.5 GB, 8 cores)

HBase Master: dharshkthvel (15.5 GB, 8 cores)

Oozie Server: dharshkthvel (15.5 GB, 8 cores)

ZooKeeper Server: dharshkthvel (15.5 GB, 8 cores)

Falcon Server: dharshkthvel (15.5 GB, 8 cores)

Nimbus: dharshkthvel (15.5 GB, 8 cores)

DRPC Server: dharshkthvel (15.5 GB, 8 cores)

Storm UI Server: dharshkthvel (15.5 GB, 8 cores)

Accumulo GC: dharshkthvel (15.5 GB, 8 cores)

dharshkthvel (15.5 GB, 8 cores)

SNameNode NameNode ResourceManager

App Timeline Server History Server

Hive Metastore WebHCat Server

HiveServer2 HBase Master Oozie Server

ZooKeeper Server Falcon Server Nimbus

DRPC Server Storm UI Server Accumulo GC

Accumulo Monitor Accumulo Tracer

Accumulo Master Infra Solr Instance

Grafana Metrics Collector

Atlas Metadata Server Kafka Broker

Knox Gateway Log Search Server

Activity Analyzer Activity Explorer

HST Server Spark History Server

Spark2 History Server Zeppelin Notebook

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localhost:8080/#/installer/step6

Ambari

admin

CLUSTER INSTALL WIZARD

Get Started

Select Version

Install Options

Confirm Hosts

Choose Services

Assign Masters

Assign Slaves and Clients

Customize Services

Review

Install, Start and Test

Summary

Assign Slaves and Clients

Assign slave and client components to hosts you want to run them on.

Hosts that are assigned master components are shown with *

"Client" will install HDFS Client, YARN Client, MapReduce2 Client, Tez Client, HCat Client, Hive Client, HBase Client, Pig Client, Sqoop Client, Oozie Client, ZooKeeper Client, Falcon Client, Accumulo Client, Infra Solr Client, Atlas Metadata Client, Spark Client, Spark2 Client, Mahout Client and Slider Client.

Host	all none	all none	all none	all none	all none	all none
dharshekthivel*	<input checked="" type="checkbox"/> DataNode	<input checked="" type="checkbox"/> NFSGateway	<input checked="" type="checkbox"/> NodeManager	<input checked="" type="checkbox"/> RegionServer	<input checked="" type="checkbox"/> Phoenix Query Server	<input checked="" type="checkbox"/> Supervisor

Show: 25 1 - 1 of 1

Back Next

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localhost:8080/#installer/step7

Ambari

admin

CLUSTER INSTALL WIZARD

- Get Started
- Select Version
- Install Options
- Confirm Hosts
- Choose Services
- Assign Masters
- Assign Slaves and Clients
- Customize Services**
- Review
- Install, Start and Test
- Summary

Customize Services

We have come up with recommended configurations for the services you selected. Customize them as you see fit.

HDFS YARN MapReduce2 Tez Hive HBase Pig Sqoop Oozie 1 ZooKeeper Falcon Storm Flume Accumulo 2 Ambari Infra Ambari Metrics 1 Atlas Kafka Knox 1 Log Search 1 SmartSense 1

Spark Spark2 Zeppelin Notebook Mahout Slider Misc

Group Default (1) Manage Config Groups Filter...

Settings Advanced

Hive Metastore

Database Password Database Password
javax.jdo.option.ConnectionPassword
password to use against metastore database
For security purposes, password changes will not be shown in configuration version comparisons

⚠ Attention: Some configurations need your attention before you can proceed.
Showing properties with issues Show all properties

Back Next

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localhost:8080/#/installer/step7

Assign Slaves and Clients

Customize Services

Review

Install, Start and Test

Summary

Warning

Derby is not recommended for production use. With Derby, Oozie Server HA and concurrent connection support will not be available.

Cancel Proceed Anyway

Password for user 'admin'

... ...

- Back Next

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localhost:8080/#installer/step8

Ambari

admin

CLUSTER INSTALL WIZARD

- Get Started
- Select Version
- Install Options
- Confirm Hosts
- Choose Services
- Assign Masters
- Assign Slaves and Clients
- Customize Services
- Review**
- Install, Start and Test
- Summary

Review

Please review the configuration before installation

Admin Name : admin

Cluster Name : chola

Total Hosts : 1 (1 new)

Repositories:

- debian7 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/debian7/2.x/updates/2.5.3.0
- debian7 (HDP-UTILS-1.1.0.21):
http://public-repo-1.hortonworks.com/HDP-UTILS-1.1.0.21/repos/debian7
- redhat6 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/centos6/2.x/updates/2.5.3.0
- redhat6 (HDP-UTILS-1.1.0.21):
http://public-repo-1.hortonworks.com/HDP-UTILS-1.1.0.21/repos/centos6
- redhat7 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/centos7/2.x/updates/2.5.3.0
- redhat7 (HDP-UTILS-1.1.0.21):
http://public-repo-1.hortonworks.com/HDP-UTILS-1.1.0.21/repos/centos7
- suse11 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/suse11sp3/2.x/updates/2.5.3.0

← Back Print Deploy →

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localhost:8080#/installer/step8

Ambari

admin

CLUSTER INSTALL WIZARD

- Get Started
- Select Version
- Install Options
- Confirm Hosts
- Choose Services
- Assign Masters
- Assign Slaves and Clients
- Customize Services
- Review**
- Install, Start and Test
- Summary

Preparing to Deploy: 3 of 96 tasks completed.

Admin Name : admin

Cluster Name : chola

Total Hosts : 1 (1 new)

Repositories:

- debian7 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/debian7/x/updates/2.5.3.0
- debian7 (HDP-UTILS-1.1.0.21):
http://public-repo-1.hortonworks.com/HDP-UTILS-1.1.0.21/repos/debian7
- redhat6 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/centos6/x/updates/2.5.3.0
- redhat6 (HDP-UTILS-1.1.0.21):
http://public-repo-1.hortonworks.com/HDP-UTILS-1.1.0.21/repos/centos6
- redhat7 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/centos7/x/updates/2.5.3.0
- redhat7 (HDP-UTILS-1.1.0.21):
http://public-repo-1.hortonworks.com/HDP-UTILS-1.1.0.21/repos/centos7
- suse11 (HDP-2.5):
http://public-repo-1.hortonworks.com/HDP/suse11sp3/x/updates/2.5.3.0

← Back Print Deploy ...

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localhost:8080/#installer/step9 admin

Install, Start and Test

Please wait while the selected services are installed and started.

3 % overall

Host	Status	Message
dharshkithvel	3%	Waiting to install Accumulo Client

Show: All (1) In Progress (1) | Warning (0) | Success (0) | Fail (0)

1 of 1 hosts showing - Show All

Show: 25 1 - 1 of 1 Next →

CLUSTER INSTALL WIZARD

- Get Started
- Select Version
- Install Options
- Confirm Hosts
- Choose Services
- Assign Masters
- Assign Slaves and Clients
- Customize Services
- Review
- Install, Start and Test
- Summary



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OpenCV

<http://opencv.org/>





Installing a r package

```
install.packages("mapdata")
```



Read CSV Data

```
StopCSVData <- read.csv(file="/home/dharshekthvel/Downloads/stop.csv", header=TRUE, sep=",")
```

With the no of rows:

```
StopCSVData <- read.csv(file="/home/dharshekthvel/Downloads/stop.csv", header=TRUE, sep=",", nrows=200)
```

Plotting a map in R

Install the below package

```
library(rworldmap)
```

```
StopCSVData <- read.csv(file="/home/dharshekthvel/Downloads/stop.csv", header=TRUE, sep=",", nrow=12000)

#map("world", fill=TRUE, col="white", bg="lightblue", ylim=c(-60, 90), mar=c(0,0,0,0))
map('worldHires','Canada', bg="lightblue")

colnames(StopCSVData) <- c("EVENT_NO","EVENT_NO_TRIP","EVENT_NO_PREV","OPD_DATE","VEHICLE_ID","MASTER_ID",
" METERS","ACT_ARR_TIME","ACT_DEP_TIME","NOM_ARR_TIME","NOM_DEP_TIME","POINT_ID","STOP_ID","STOP_POS","DISTANCE_TO_NEXT",
" DISTANCE_TO_TRIP","DOORS_OPENING","POSITIONING_METHOD","STOP_TYPE","GPS_LONGITUDE","GPS_LATITUDE","PATTERN_IDX","DOO
R_OPEN_TIME","POINT_ROLE","POINT_ACTION","PLAN_STATUS")
head(StopCSVData$GPS_LONGITUDE, StopCSVData$GPS_LATITUDE)

points(StopCSVData$GPS_LONGITUDE, StopCSVData$GPS_LATITUDE, col = "red", cex = 0.4)
```



kubernetes



kubernetes

Installing Kubernetes

[1] Install kubectl

```
$ sudo snap install kubectl --classic
```





TensorFlow

TensorFlow is the library from Google for Deep learning.

Machine learning framework developed by Google for training deep learning models.

Used to do numerical computations through data flow graphs.

Nodes represent operations and edges represent data.



Install Tensorflow

To install tensorflow follow the below steps:

```
$ sudo apt-get install python-pip python-dev python-virtualenv
```

```
$ virtualenv --system-site-packages
```

```
$ source ~/tensorflow/bin/activate
```

```
$ pip install --upgrade tensorflow
```

```
$ (tensorflow)$ deactivate
```



To check if everything works perfectly:

```
import tensorflow as tf
statement = tf.constant("\n\n\n Tensor flow is installed correctly...")
sess = tf.Session()
print(sess.run(statement))
```



The Basics

A tensor is represented in 3D space by array of 3^R numbers (R-Rank)

In a N dimensional space, tensors require N^R numbers



The Basics

Rank of a tensor object denotes number of dimensions

Rank 0 means a scalar

Rank 1 vector

Rank 2 Matrix

Rank3 meaning 3-Tensor



The Basics

Shape of a tensor object denotes number of elements in each dimension.



Projects, Use cases Architectures

B Express



Scope and work

- 1 Sentiment analysis of investments.
- 2 Sentiment analysis on new products.
- 3 Heat map analysis of net promoter score on new products.

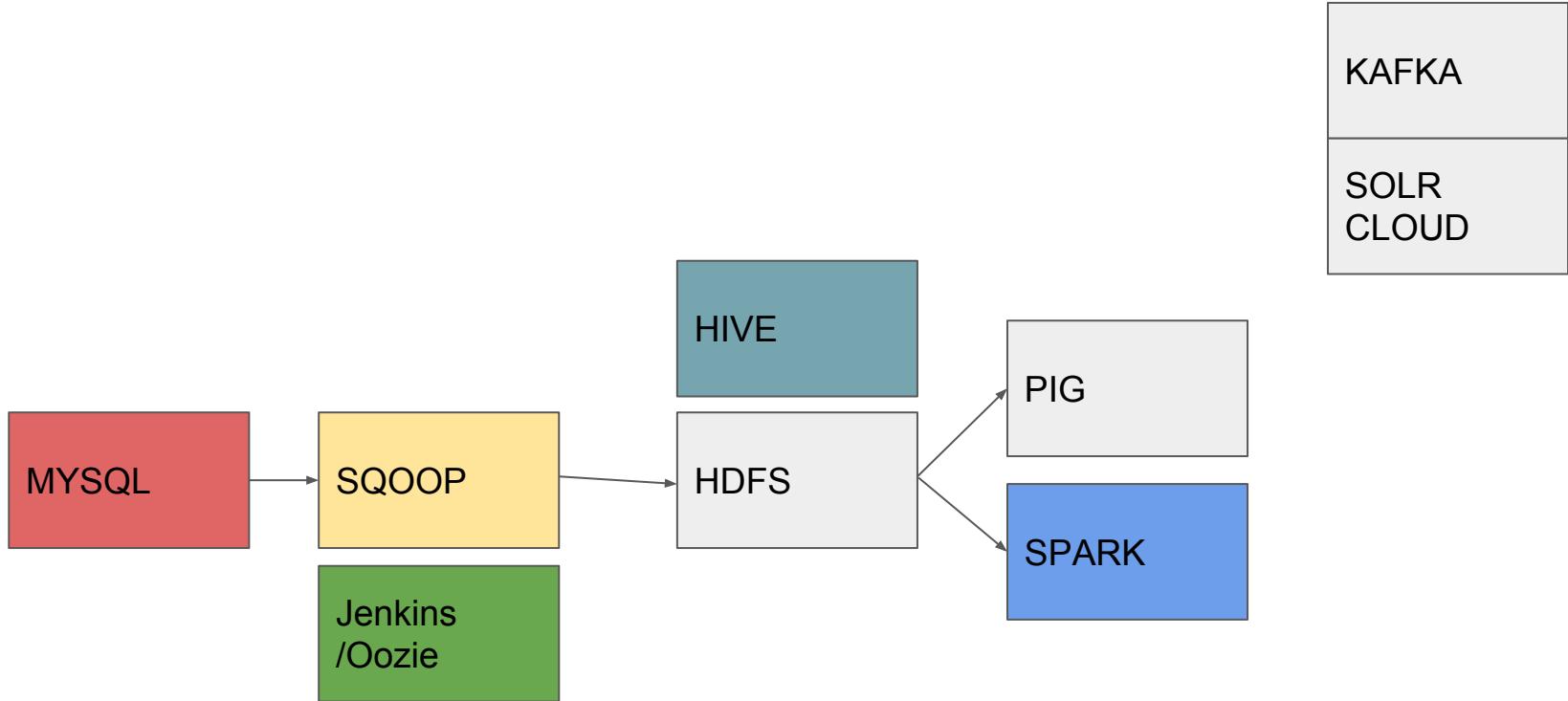
Advantages to Bank

- 1 Quick analysis of Investments, reduces manual effort of analysing shares and commodities.
- 2 Assessment of new products success
- 3 Assessment of regional sentiments

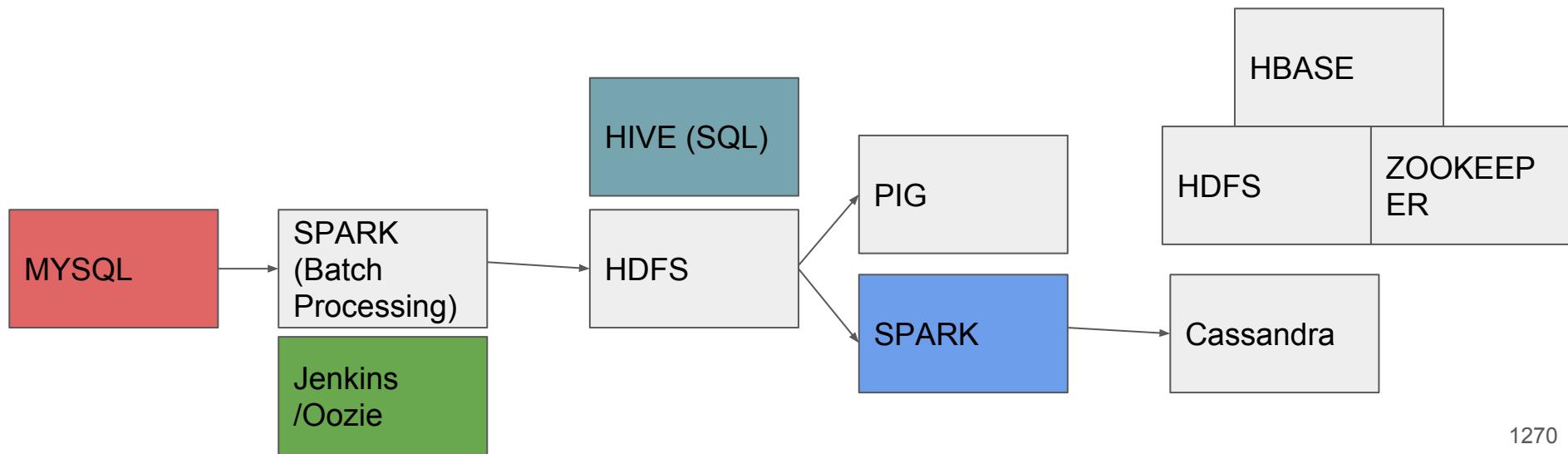
Big Data Architectures



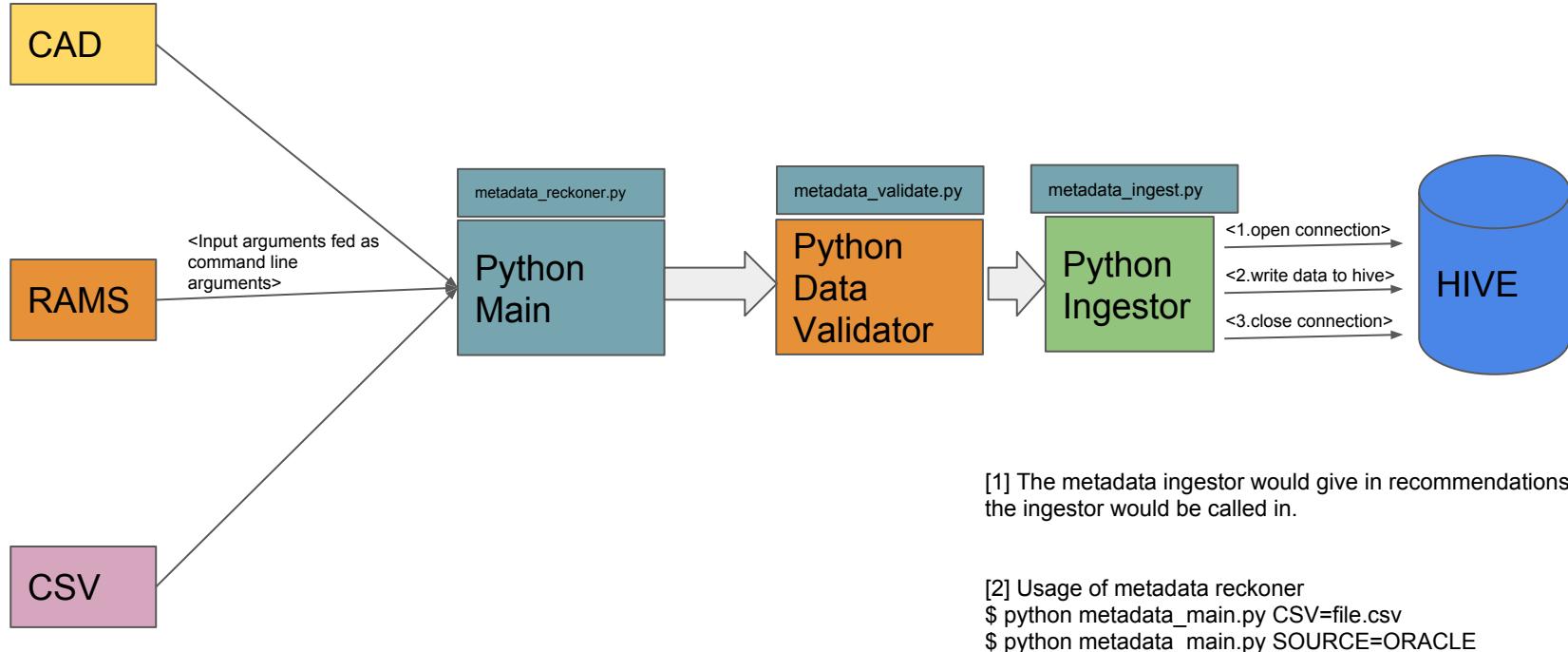
Big Data Architectures



Big Data Architectures



Metadata Ingestion in Hive



Metadata Ingestion in Hive

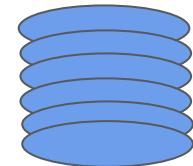
1. main() gets invoked from command line
2. main() calls in **class** MetaDataReckoner. runMetaDataReckoner
3. MetaDataInputArgumentValidator.validateCommandLineArguments()
4. After validation of input arguments,

```
meta_data_validator = MetaDataValidator()  
meta_data_validator.validateInput()
```

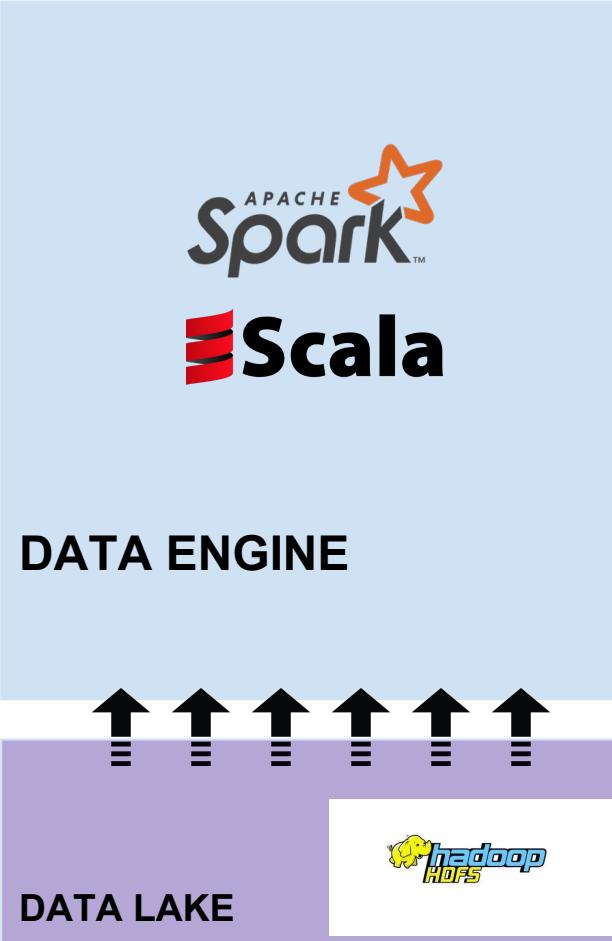
Teradata

Decommissioning

Architecture



Teradata



Thank you

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