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Data Science With Python

Python Integration with Hadoop MapReduce and Spark

Learning Objectives

By the end of this lesson, you will be able to:

- Explain why Python should be integrated with Hadoop
- Outline the ecosystem and architecture of Hadoop
- Explain the functioning of MapReduce
- Discuss Apache Spark functions and their benefits
- Write Python programs for Hadoop operations

Quick Recap: Need for Real-Time Analytics

We have seen how big data is generated and understood that to extract insights, proper analysis of data is more important than its size.

Quick Recap: Need for Real-Time Analytics

Real-time analytics is the rage right now because it helps extract information from different data sources almost instantly.

Date	Description	Deposit	Withdrawal	Balance
Apr 1	ATM Post Debit		100	$200,000
Apr 2	Paypal Transfer 231054	200		$202,000
Apr 3	Simplilearn course fee		150	$200,500
Apr 4	Starluck Café		210	$198,400
Apr 5	Walcart TX		230	$196,100
Apr 6	ebuy swiss watch 239		250	$193,600
Apr 7	Caterpallor black boots men		270	$190,900
Apr 8	Halo blue shirt 831		160	$189,300

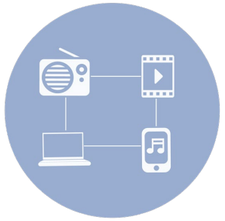
Information source; overall patterns not clearly visible

Quick Recap: Need for Real-Time Analytics

Demographics

Orders

Products



Visits/Channels

Social Media Sentiments

Customer Support and Surveys

Real-Time Analytics

Higher Conversion

Targeted Marketing

Better Customer Satisfaction

Increased Sales

Quick Recap: Why Python

Data Scientists all over the world prefer Python because it is an easy -to-use language that has diverse libraries required for analytics.

Data Science

Acquire

Wrangle

Explore

Model

Visualize

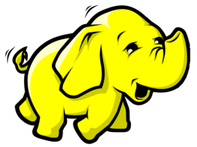
Bokeh

Disparity in Programming Languages

However, Big Data can only be accessed through Hadoop which is completely developed and implemented in Java. Also, analytics platforms are coded in different programming languages.

Data Science

Python



Hadoop Infrastructure (HDFS)

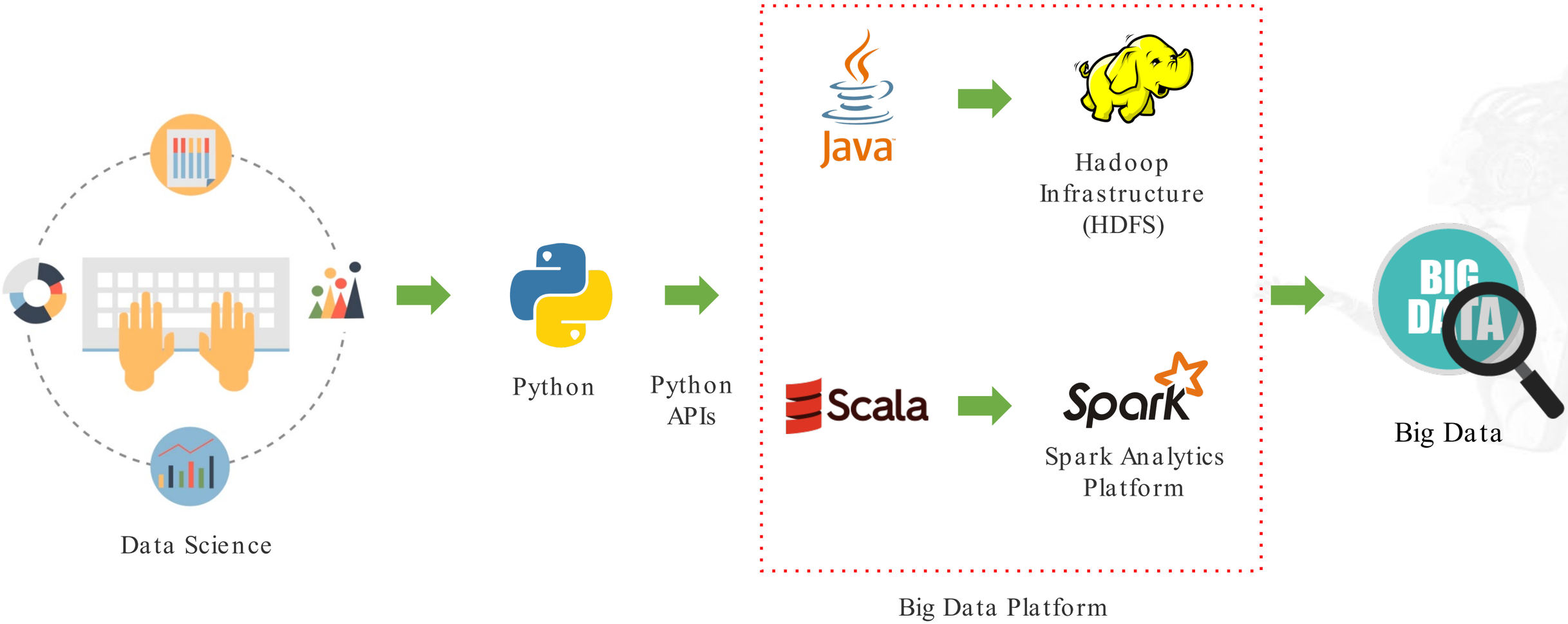
Spark Analytics Platform

Big Data Platform

Big Data

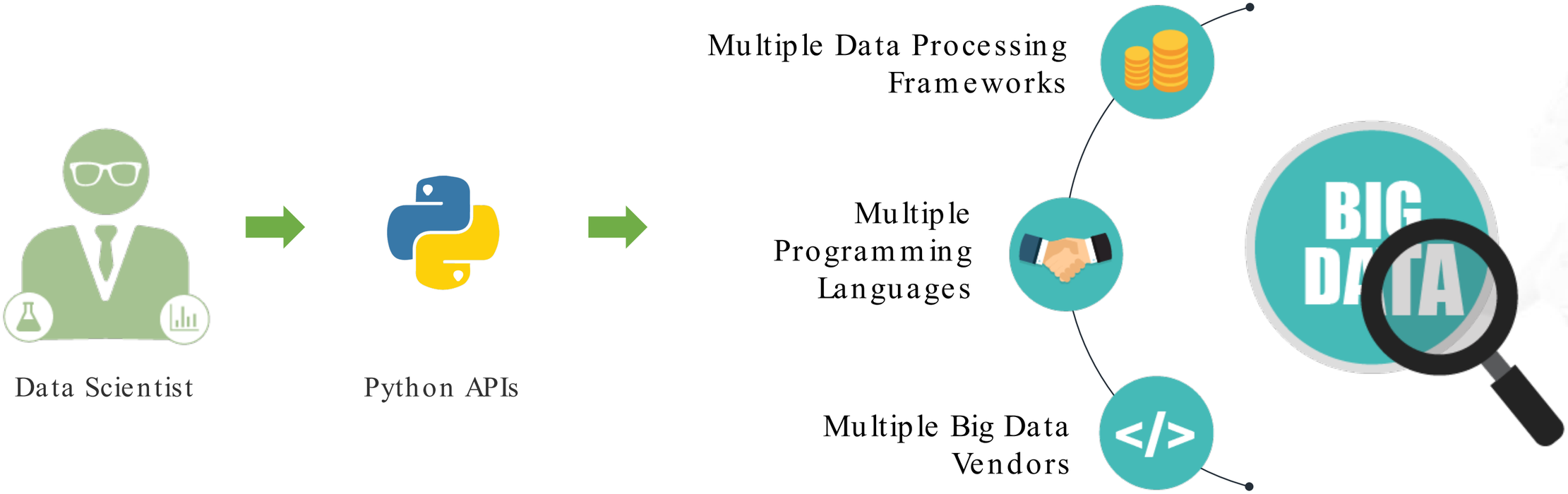
Integrating Python with Hadoop

As Python is a Data Scientist's first language of choice, both Hadoop and Spark provide Python APIs that allow easy access to the Big Data platform.

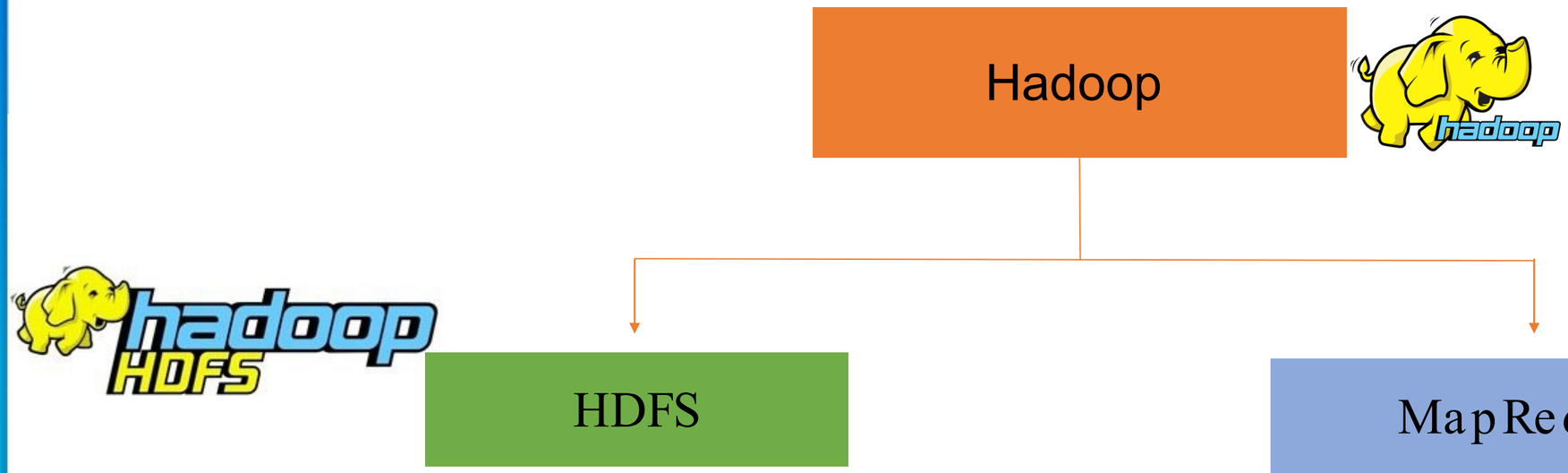


Need for Big Data Solutions in Python

There are several reasons for creating Big Data solutions in Python.



Hadoop: Core Components

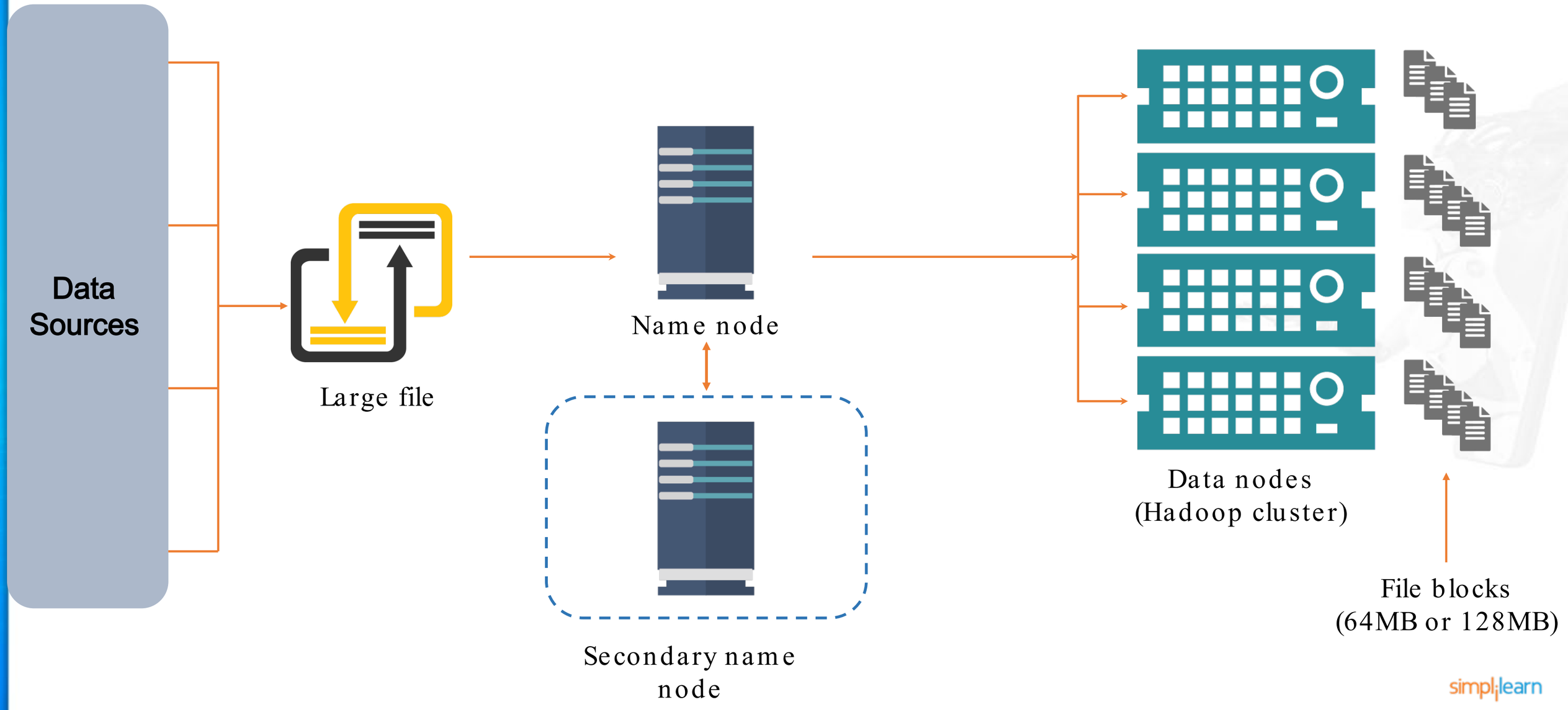


- It is responsible for storing data on a cluster
- Data is split into blocks and distributed across multiple nodes in a cluster
- Each block is replicated multiple times
  - Default is 3 times
  - Replicas are stored on different nodes

- MapReduce is a data processing framework to process data on the cluster
- Two consecutive phases: Map and Reduce
- Each map task operates on discrete portions of data
- After map, reduce works on the intermediate data distributed on nodes

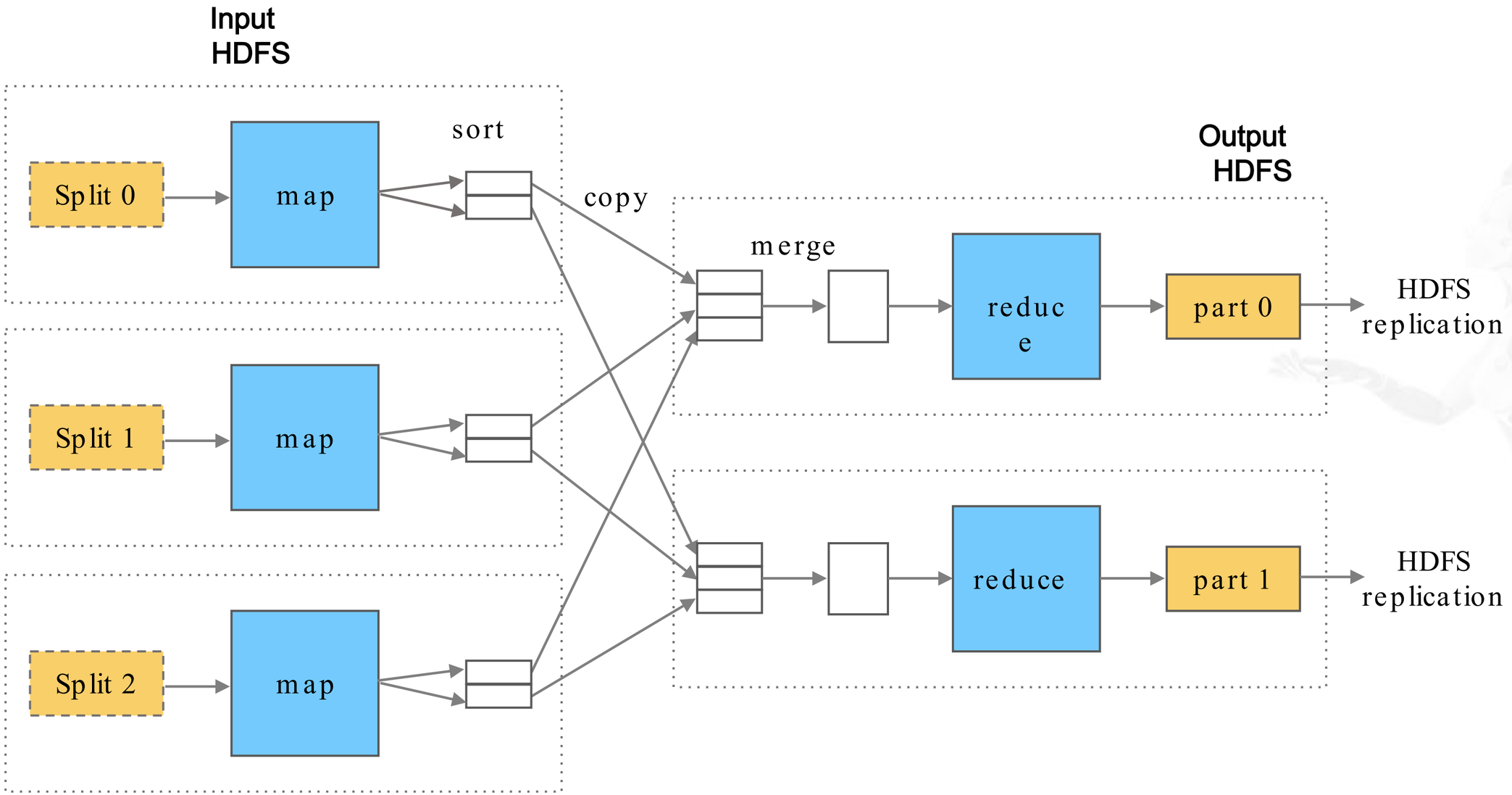
Hadoop: System Architecture

This example illustrates the Hadoop system architecture and the ways to store data in a cluster.



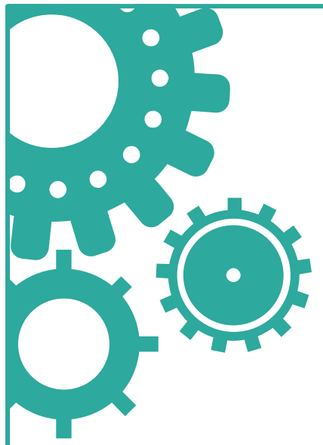
MapReduce

The second core component of Hadoop is MapReduce, the primary framework of the HDFS architecture.



MapReduce: Mapper and Reducer

Let us discuss the MapReduce functions, mapper and reducer, in detail.



Mapper

- Mappers run locally on the data nodes to avoid the network traffic.
- Multiple mappers run in parallel processing a portion of the input data.
- The mapper reads data in the form of key-value pairs.
- If the mapper write generates an output, it is written in the form of key -value pairs.

Reducer

- All intermediate values for a given intermediate key are combined together into a list and given to a reducer.
- This step is known as **shuffle** and **sort** .
- The reducer outputs either zero or more final key-value pairs. These are written to HDFS.

Hadoop Streaming: Python API for Hadoop

Hadoop Streaming acts like a bridge between your Python code and the Java -based HDFS, and lets you seamlessly access Hadoop clusters and execute MapReduce tasks.

Data Scientist

Hadoop Streaming

Python API

Mapper in Python

Python supports map and reduce operations:

Suppose you have list of numbers you want to square = [1, 2, 3, 4, 5, 6]

Square function is written as follows:

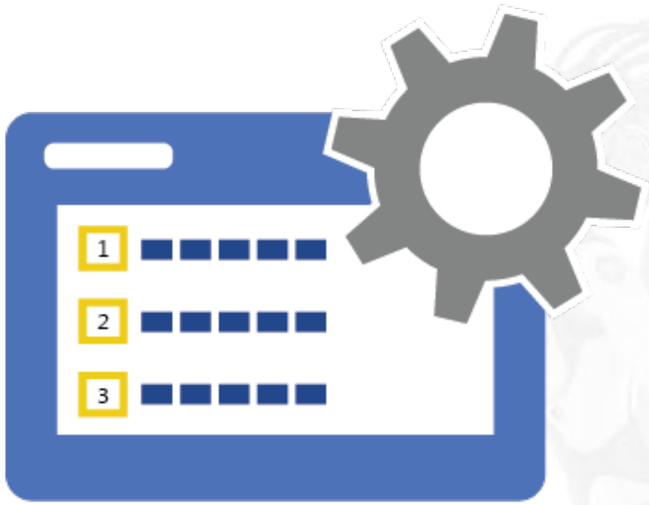
```
def square(num):
    return num * num
```

You can square this list using the following code:

```
squared_nums = map(square, numbers)
```

Output would be:

[1, 4, 9, 16, 25, 36]



Reducer in Python

Suppose you want to sum the squared numbers:
[1, 4, 9, 16, 25, 36]

Use the **sum** function to add two numbers

```
def sum(a, b ):
    return a + b
```

You can now sum the numbers using the **reduce** function

```
Import functools as f
sum_squared = f. reduce(sum, a)
```

Output would be:

[91]

Setting Up Cloudera QuickStart Virtual Machine

Cloudera provides enterprise-ready Hadoop Big Data platform which supports Python as well.
To set up the Cloudera Hadoop environment, visit the Cloudera link:

http://www.cloudera.com/downloads/quickstart_vms/5 -7.html

Cloudera recommends that you use 7-Zip to extract these files. To download and install it, visit the link:
http://www.7-zip.org/

Cloudera QuickStart VM: Prerequisites

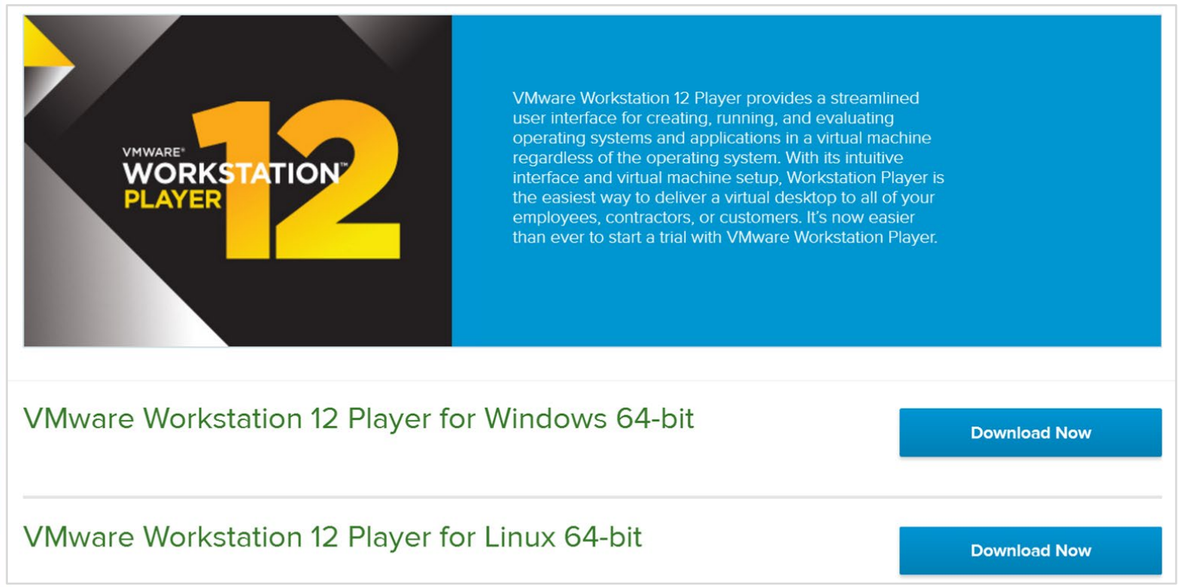
- These 64-bit VMs require a 64 -bit host OS and a virtualization product that can support a 64 -bit guest OS.
- To use a VMware VM, you must use a player compatible with WorkStation 8.x or higher:
  - Player 4.x or higher
  - Fusion 4.x or higher
- Older versions of WorkStation can be used to create a new VM using the same virtual disk (VMDK file), but some features in VMware tools are not available.
- The amount of RAM required varies by the run -time option you choose

CDH and Cloudera Manager Version	RAM Required by VM
CDH 5 (default)	4+ GiB*
Cloudera Express	8+ GiB*
Cloudera Enterprise (trial)	10+ GiB*

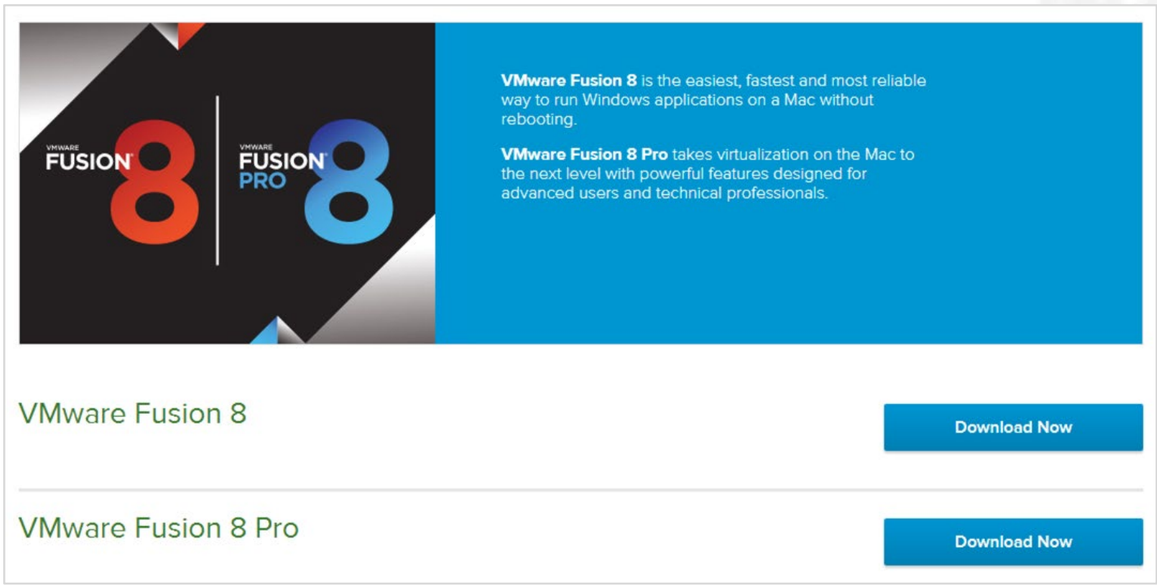
Launching VMware Image

To launch the VMware, visit the VMware link:

https://www.vmware.com/products/player/playerpro-evaluation.html

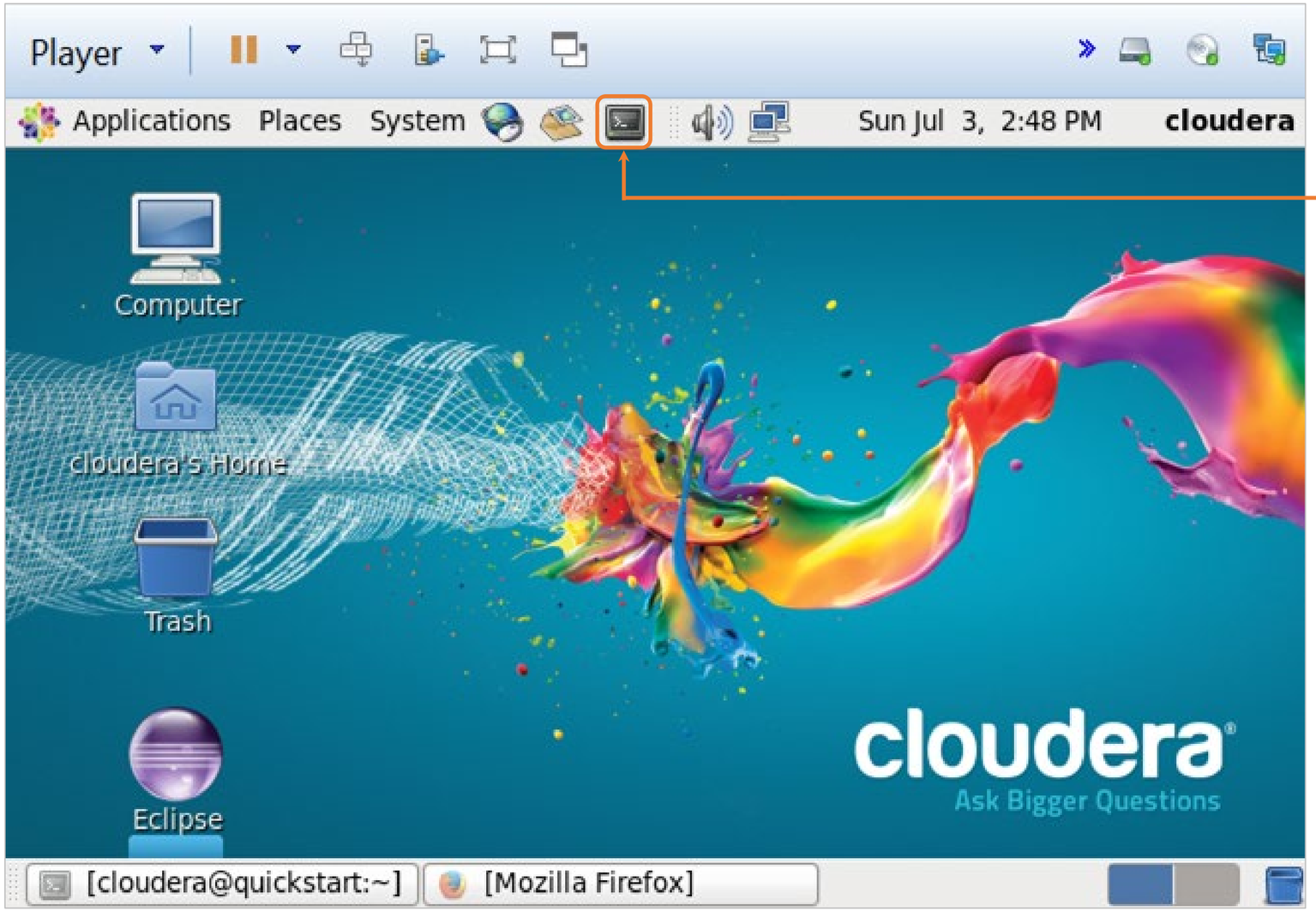


https://www.vmware.com/products/fusion/fusion-evaluation.html



QuickStart VMware Image

Launch VMware player with Cloudera VM



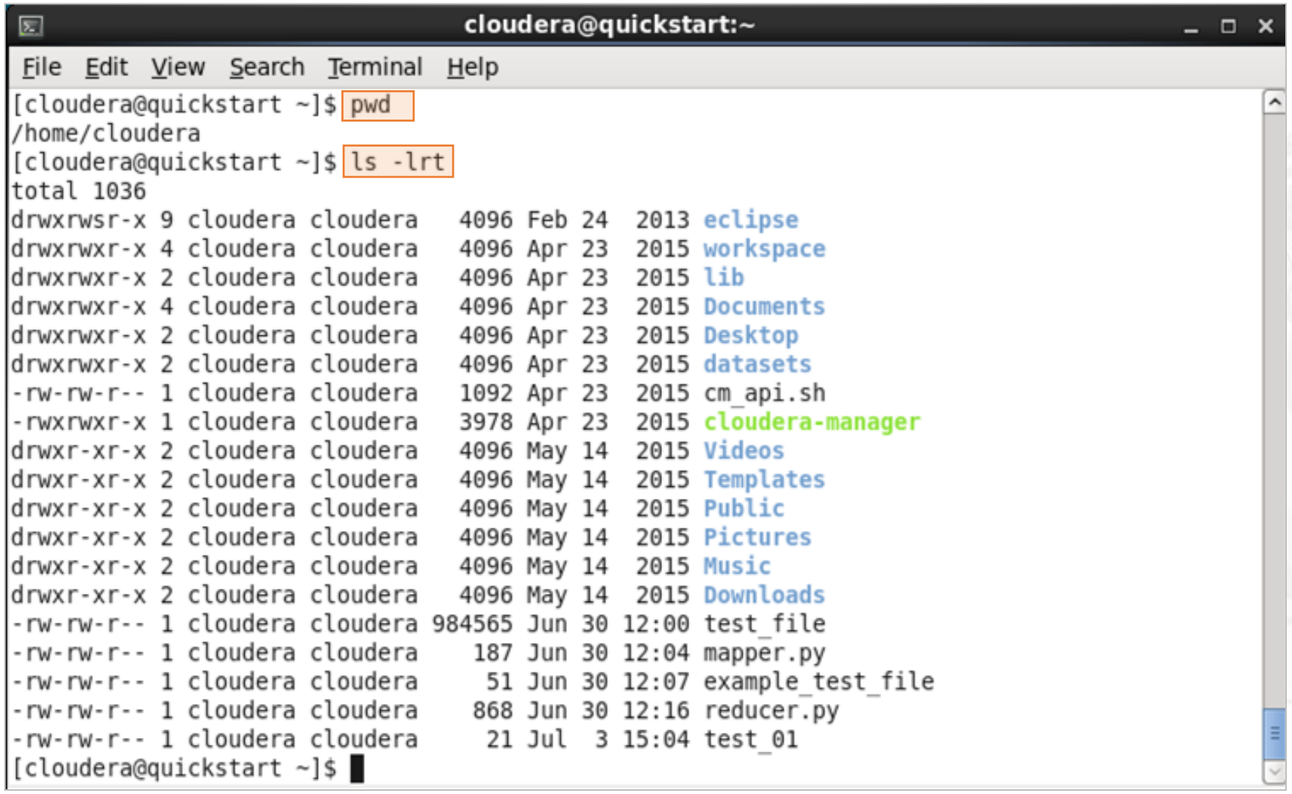
Launch Terminal

Account:
username: cloudera
password: cloudera

QuickStart VM Terminal

Step 1

Step 2



Unix command :

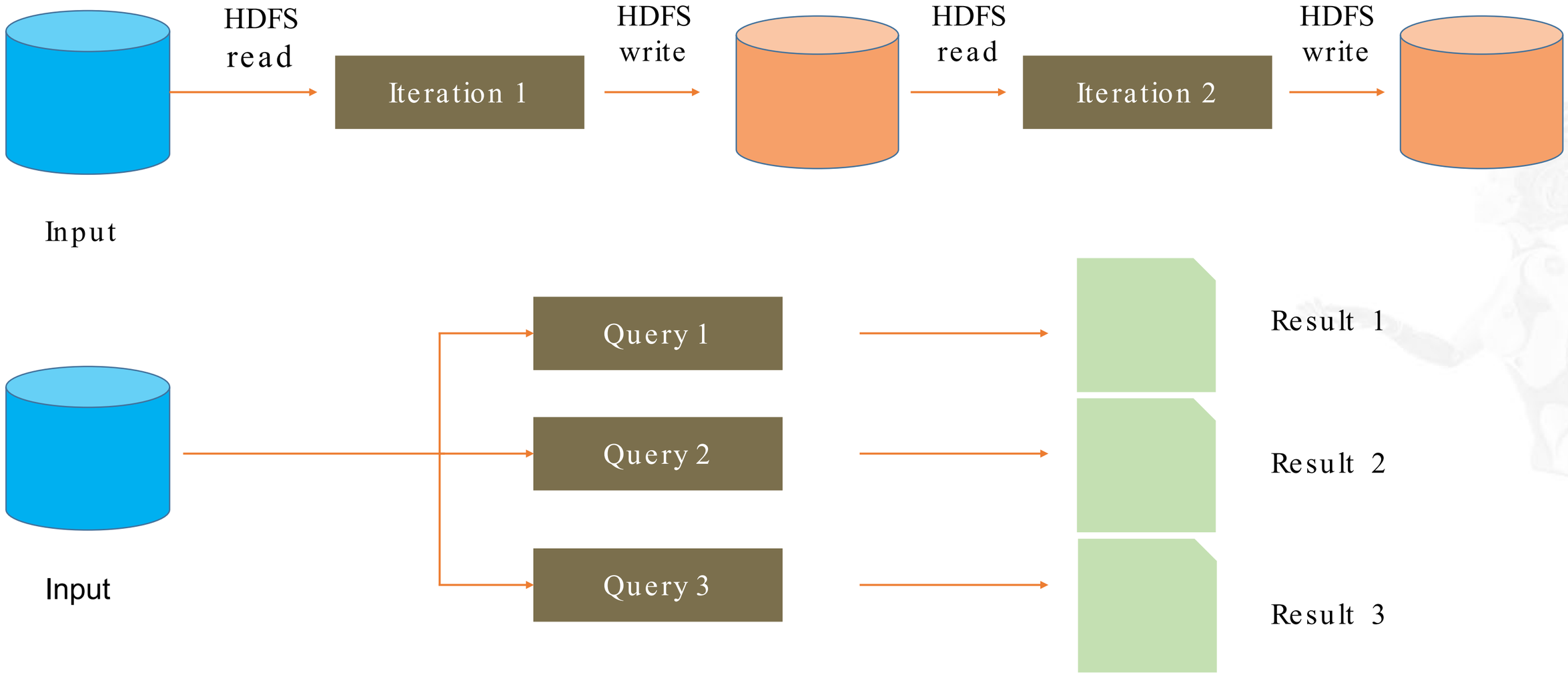
- pwd to verify present working directory
- ls -lrt to list files and directories

Using Hadoop Streaming for Calculating Word Count

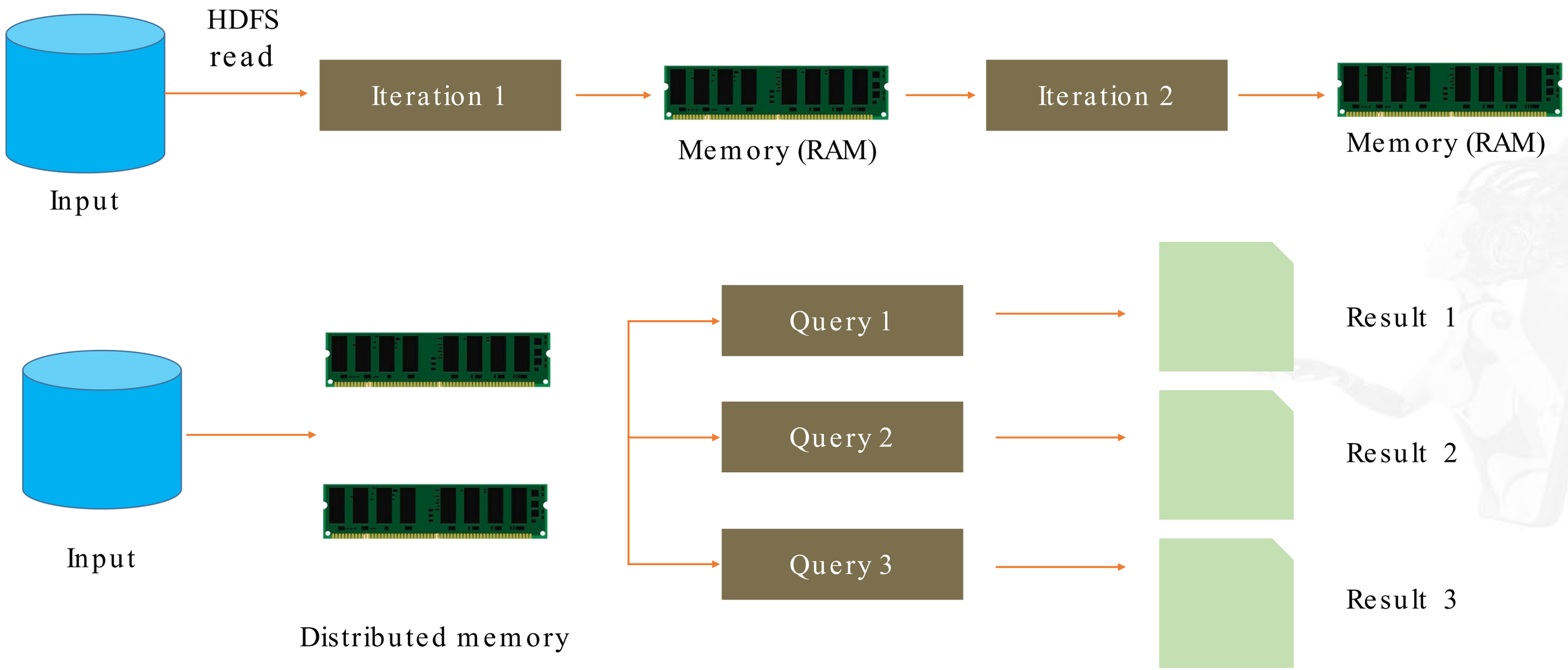
Demonstrate how to create a MapReduce program and use Hadoop Streaming to determine the word count of a document

ASSISTED PRACTICE

MapReduce Uses Disk I/O Operations

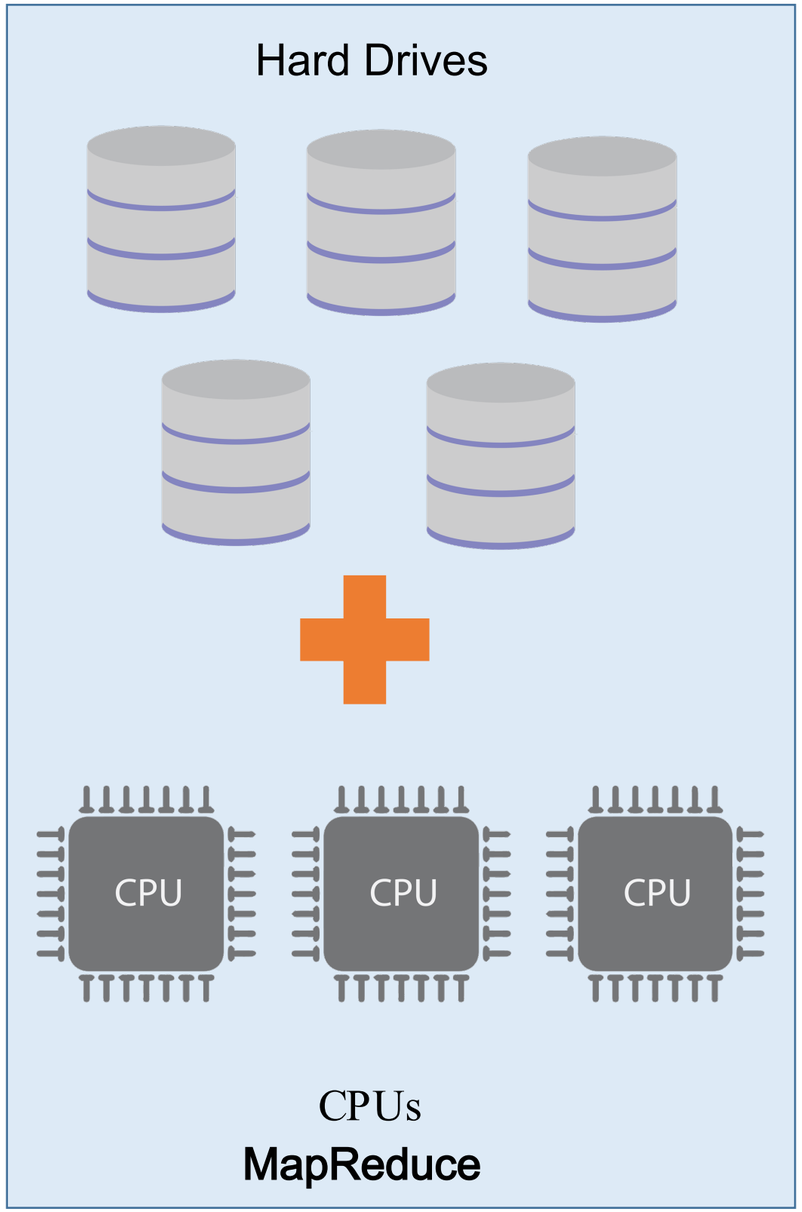


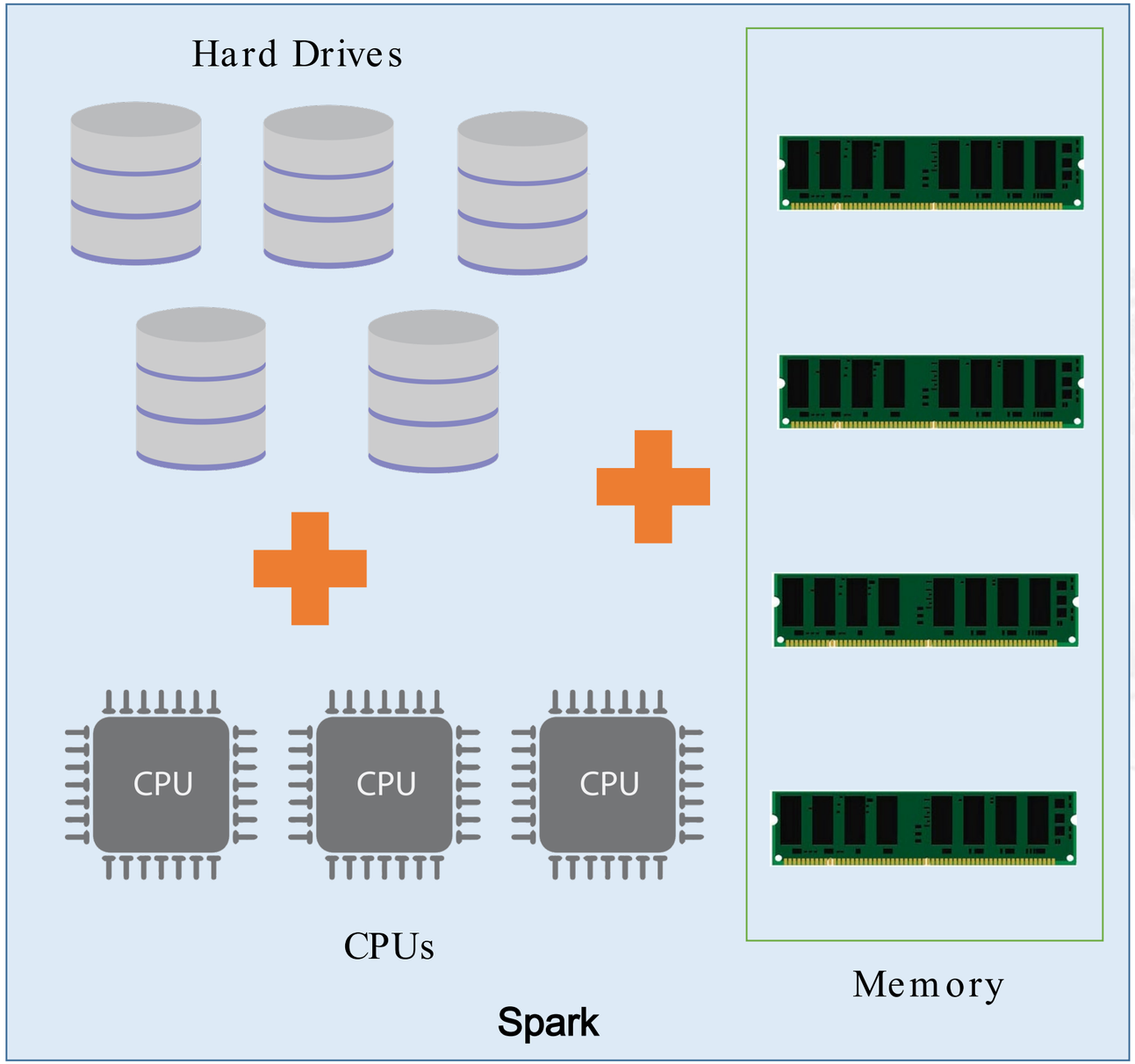
Apache Spark Uses In-Memory Instead of Disk I/O



10-100 X faster than network and disk

Hardware Requirements for MapReduce and Spark





Apache Spark Resilient Distributed Systems (RDD)

Some basic concepts about Resilient Distributed Datasets (RDD) are:

- The main programming approach of Spark is RDD.
- They are fault-tolerant collections of objects spread across a cluster that you can operate on in parallel. They can automatically recover from machine failure.
- You can create an RDD either by copying the elements from an existing collection or by referencing a dataset stored externally.
- RDDs support two types of operations: transformations and actions.
  - Transformations use an existing dataset to create a new one.
    - Example: Map, filter, join
  - Actions compute on the dataset and return the value to the driver program.
    - Example: Reduce, count, collect, save

If the available memory is insufficient, then the data is written to disk.

Advantages of Spark

Faster:	10 to 100 times faster than Hadoop MapReduce
Simplified:	• Simple data processing framework • Interactive APIs for Python for faster application development
Efficient:	Has multiple tools for complex analytics operations
Integrated:	Can be easily integrated with existing Hadoop infrastructure

PySpark: Python API for Spark

PySpark is the Spark Python API which enables data scientists to access Spark programming model.

Data Scientist

PySpark

Python API

PySpark: RDD Transformations and Actions

Transformation

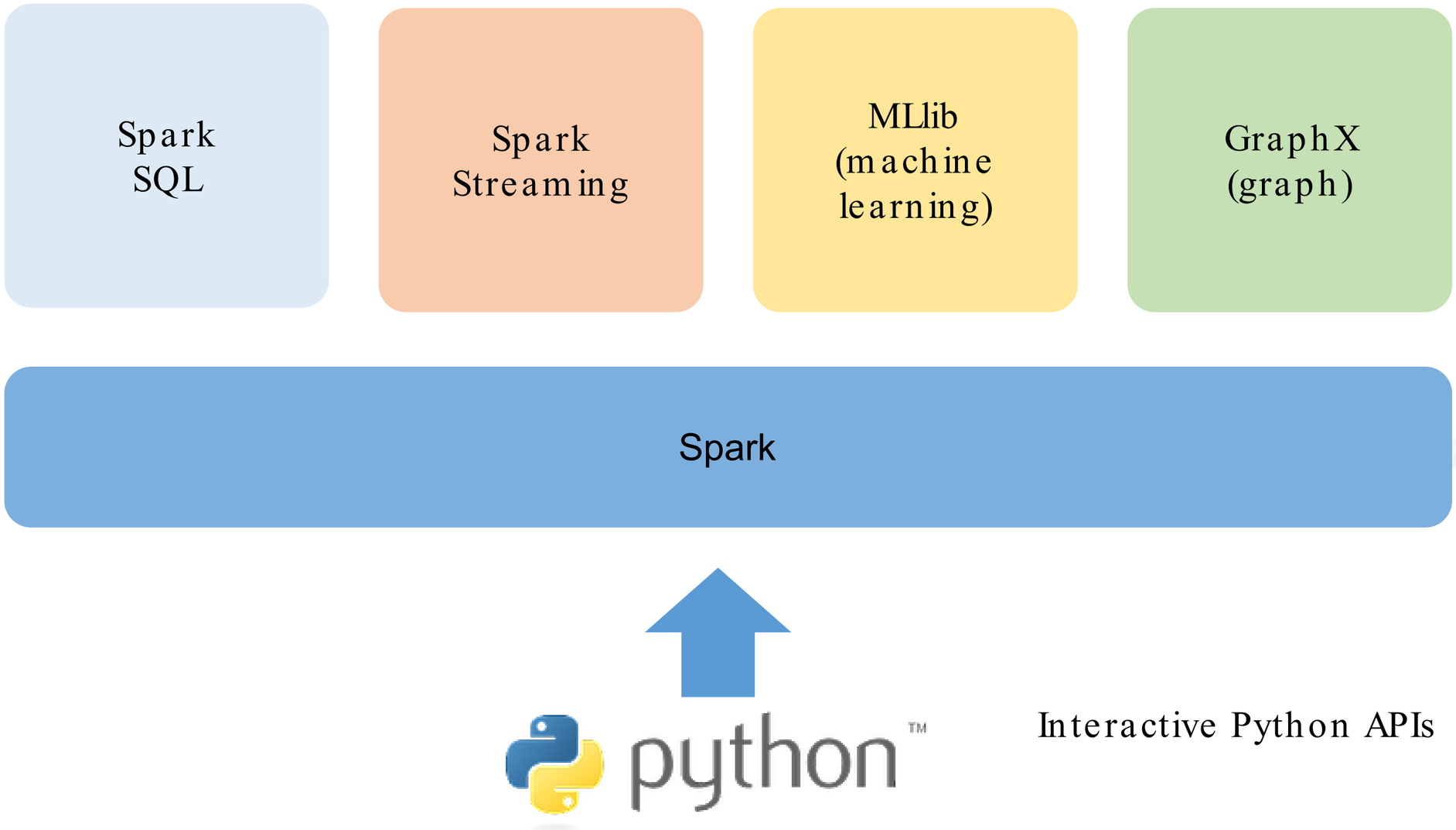
Transformation	Description
map()	Returns RDD, formed by passing data element of the source
filter()	Returns RDD based on selection
flatMap()	Maps items present in the dataset and returns sequence
reduceByKey()	Returns key value pairs where values for which each key is aggregated by value

Action

Action	Description
collect()	Returns all elements of the dataset as an array
count()	Returns the number of elements present in the dataset
first()	Returns the first element in the dataset
take(n)	Returns number of elements (n) as specified by the number in the parenthesis

SparkContext or SC is the entry point to spark for the spark application

Spark Tools

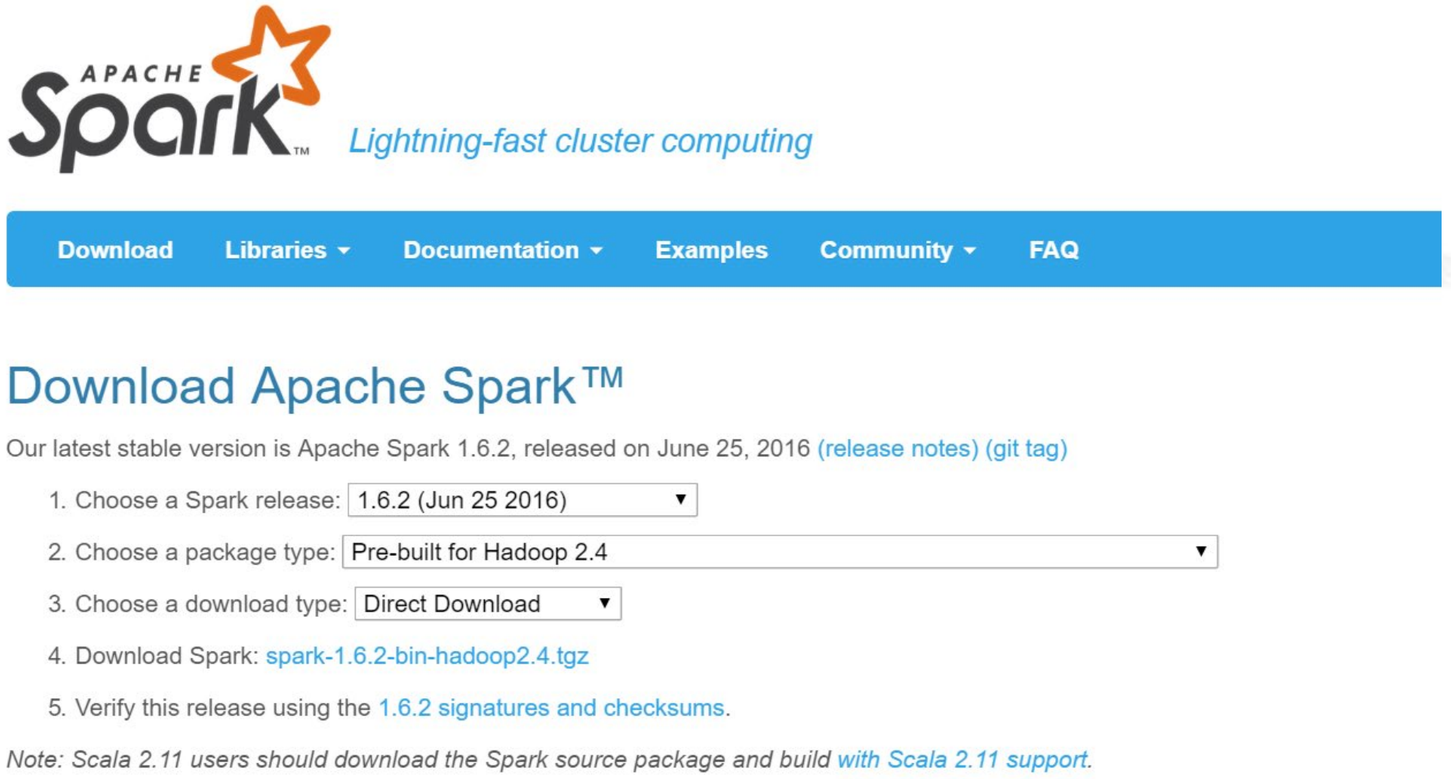


Setting Up Apache Spark

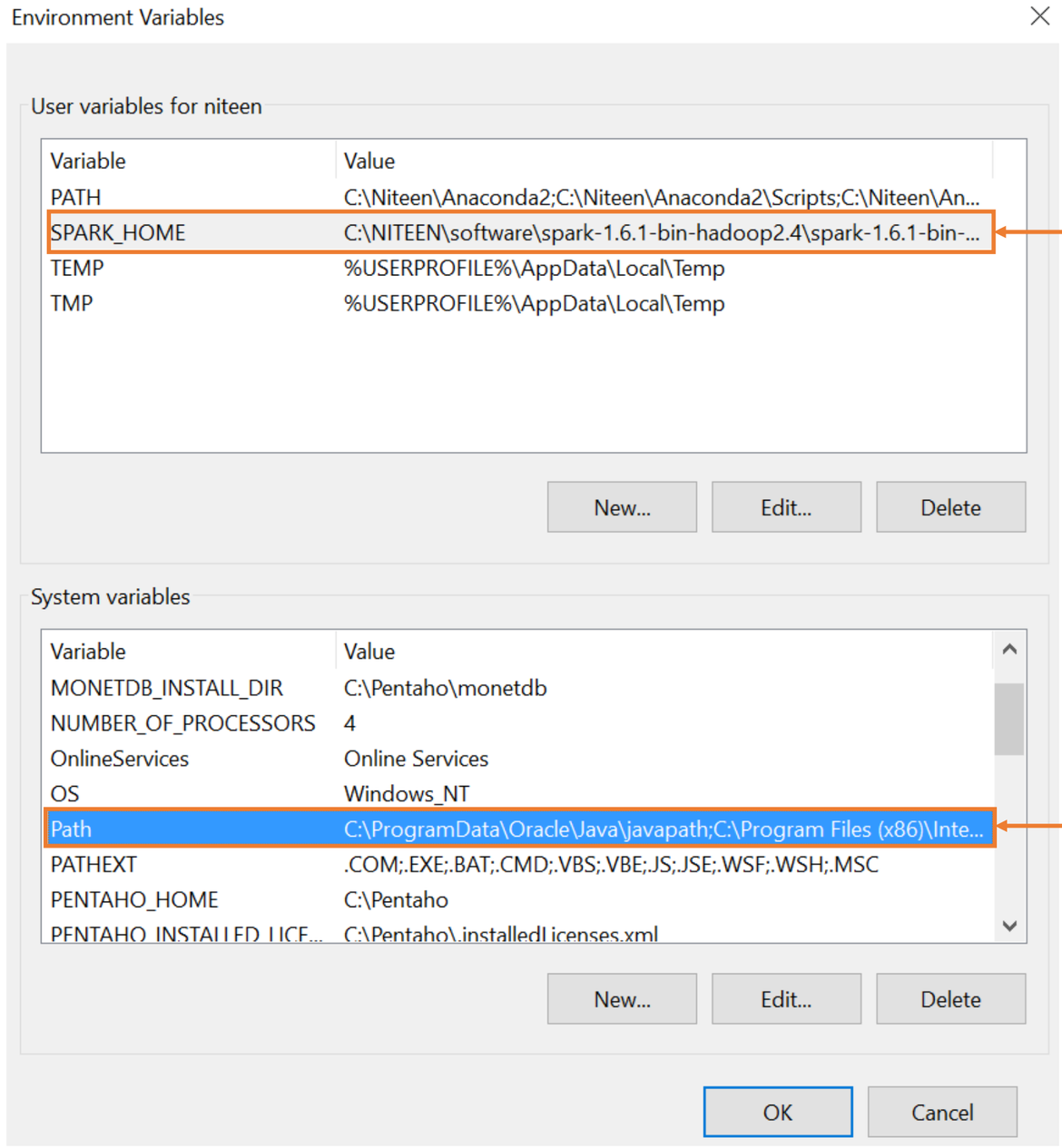
To set up the Apache Spark environment, access the link:

http://spark.apache.org/downloads.html

Please use 7-Zip to extract these files.



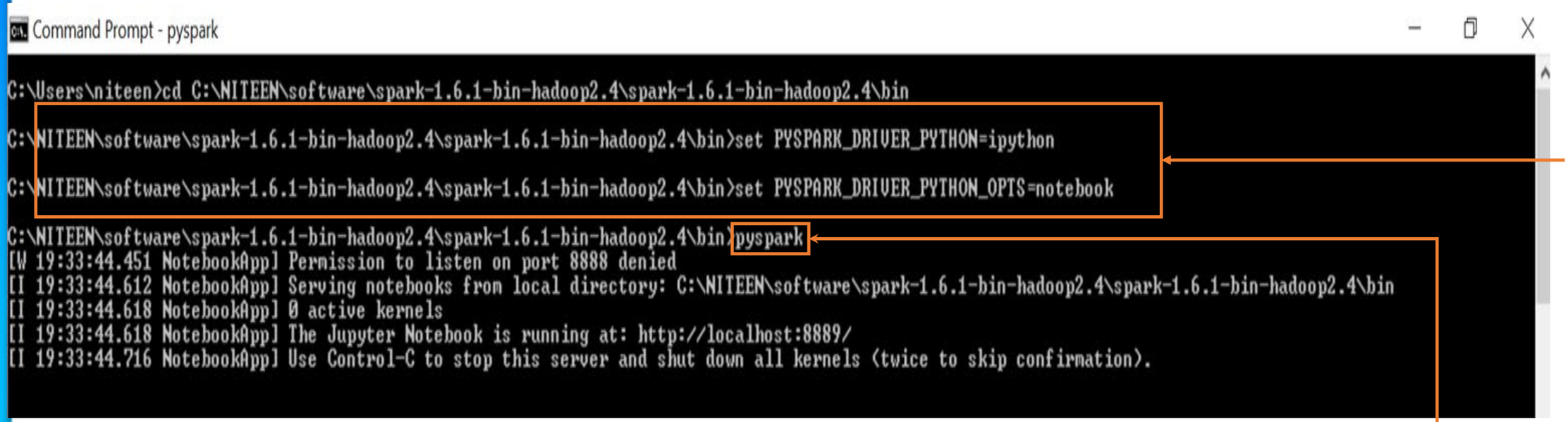
Setting Up Environmental Variable of Apache Spark



[installed directory] \spark-1.6.1-bin-hadoop2.4\spark-1.6.1-bin-hadoop2.4

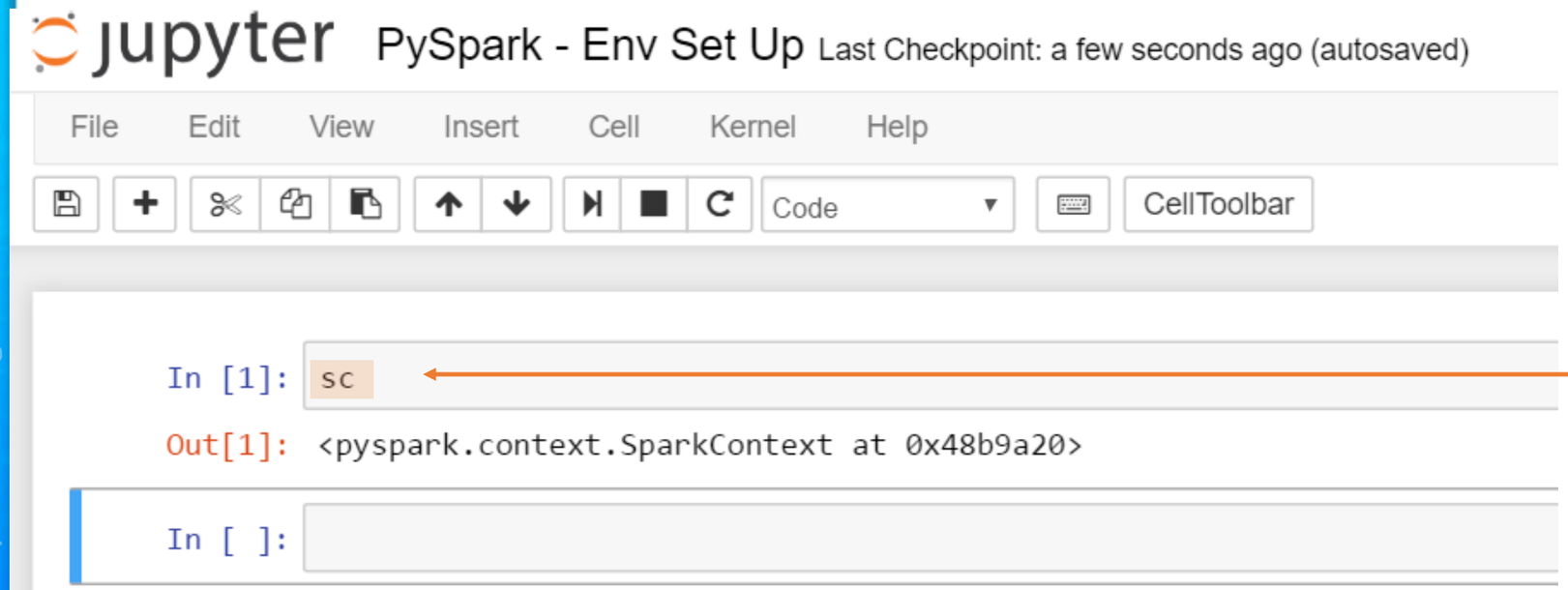
[installed directory] \spark-1.6.1-bin-hadoop2.4\spark-1.6.1-bin-hadoop2.4\bin

Integrating Jupyter Notebook with Apache Spark



Setup the pyspark notebook specific variables

Run the pyspark command



Check SparkContext

Using PySpark to Determine Word Count

Demonstrate how to use the Jupyter integrated PySpark API to determine the word count of a given dataset

ASSISTED PRACTICE

Word Count

Determine the word count of the given Amazon dataset:

- Create a MapReduce program to determine the word count of the Amazon dataset
- Submit the MapReduce task to HDFS and run it
- Verify the output

UNASSISTED PRACTICE

Word Count

Use the given dataset to count and display all the airports based in New York using PySpark. Perform the following steps:

- View all the airports listed in the dataset
- View only the first 10 records
- Filter the data for all airports located in New York
- Clean up the dataset if required

UNASSISTED PRACTICE

DATA AND
ARTIFICIAL INTELLIGENCE

Knowledge Check

Knowledge Check 1	What are the core components of Hadoop? *Select all that apply.*

a. MapReduce

b. HDFS

c. Spark

d. RDD

Knowledge Check 1	What are the core components of Hadoop? *Select all that apply.*

a. MapReduce

b. HDFS

c. Spark

d. RDD

The correct answer is **a and b**

MapReduce and HDFS are the core components of Hadoop.

Knowledge Check 2	MapReduce is a data processing framework which gets executed _____.

a. at DataNode

b. at NameNode

c. on client side

d. in memory

Knowledge Check 2	MapReduce is a data processing framework which gets executed _____.

a. at DataNode

b. at NameNode

c. on client side

d. in memory

The correct answer is **a**

The MapReduce program is executed at the data node and the output is written to the disk .

Knowledge Check 3	Which of the following functions is responsible for consolidating the results produced by each of the Map() functions/tasks?

a. Reducer

b. Mapper

c. Partitioner

d. All of the above

Knowledge Check

3

Which of the following functions is responsible for consolidating the results produced by each of the Map() functions/tasks?

a. Reducer

b. Mapper

c. Partitioner

d. All of the above

The correct answer is **a**

Reducer combines or aggregates results produced by mappers.

Knowledge Check 4	What transforms input key -value pairs to a set of intermediate key -value pairs?

a. Mapper

b. Reducer

c. Combiner

d. Partitioner

Knowledge Check 4	What transforms input key -value pairs to a set of intermediate key -value pairs?

a. Mapper

b. Reducer

c. Combiner

d. Partitioner

The correct answer is **a**

Mapper processes input data to intermediate key -value pairs which are in turn processed by reducers.

Key Takeaways

You are now able to:

- Explain why Python should be integrated with Hadoop
- Outline the ecosystem and architecture of Hadoop
- Explain the functioning of MapReduce
- Discuss Apache Spark functions and their benefits
- Write Python programs for Hadoop operations

Stock Market Data Analysis

Import the financial data using Yahoo data reader for the following companies:

- Yahoo
- Apple
- Amazon
- Microsoft
- Google

Perform fundamental data analysis

- Fetch the previous year's data
- View the values of Apple's stock
- Display the plot of closing price
- Display the stock trade by volume
- Plot all companies' data together for closing prices

COURSE-END PROJECT

Stock Market Data Analysis

Perform Daily Return Analysis and show the relationship between different stocks

- Plot the percentage change plot for Apple’s stock
- Show a joint plot for Apple and Google
- Use PairPlot to show the correlation between all the stocks

Perform risk analysis

COURSE-END PROJECT

Titanic Data Set Analysis

On April 15, 1912, the Titanic sank after colliding with an iceberg, killing 1502 out of 2224 passengers and crew. This tragedy shocked the world and led to better safety regulations for ships. Here, we ask you to perform the analysis through the exploratory data analysis technique. In particular, we want you to apply the tools of machine learning to predict the survived passengers.

COURSE-END PROJECT

Titanic Data Set Analysis

The details of these projects and their scope are below:

Data acquisition of the Titanic dataset

- Train dataset
- Test dataset

Perform the Exploratory Data Analysis (EDA) for train dataset

- Passengers age distribution
- Passengers survival by age
- Passengers survival breakdown
- Passengers class distribution
- Passengers embarkation by locations

COURSE-END PROJECT

Titanic Data Set Analysis

Perform machine learning to train the model and

- Create user defined function to load train data set
- Create user defined function to load test data set
- Create machine model
- Train the machine
- Predict whether a passenger survived the tragedy or not
- Persist the mode for future re -use

COURSE-END PROJECT

DATA AND
ARTIFICIAL INTELLIGENCE

Thank You

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