INTRODUCTION TO APACHE SPARK

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June 2016

WHAT IS APACHE SPARK?

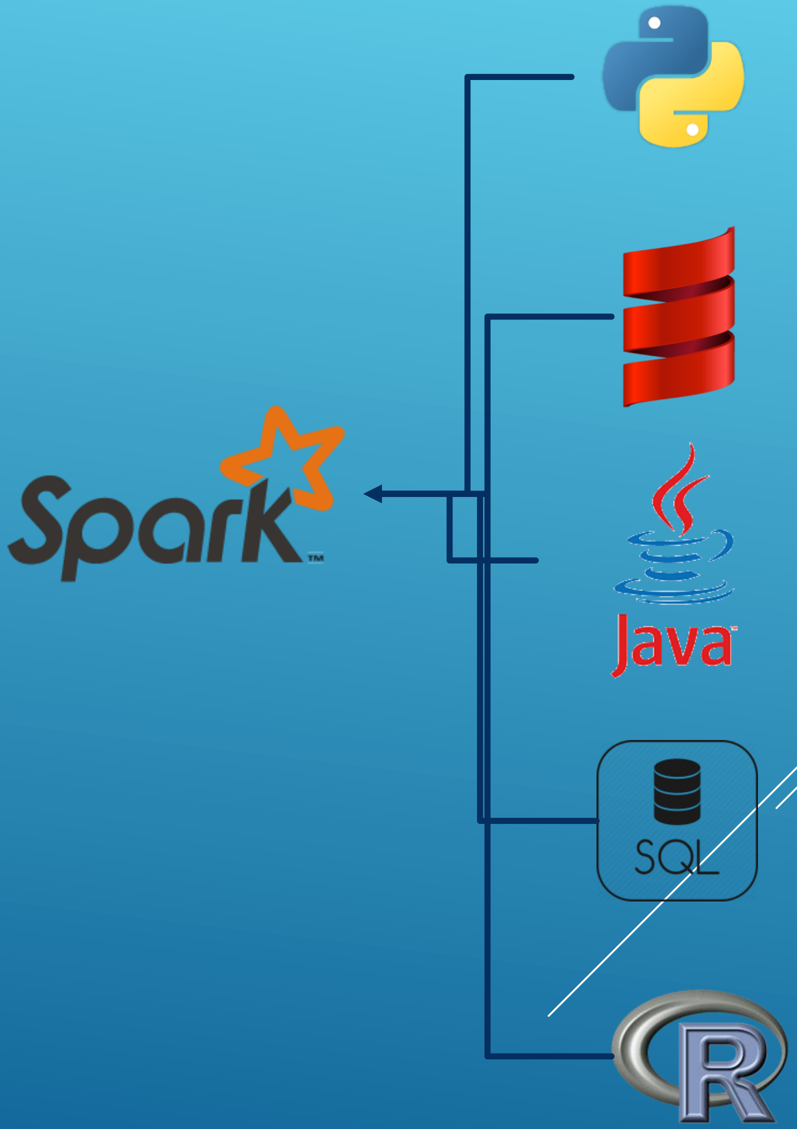
- Apache Spark or (just Spark) is a fast and general engine for processing large-scale datasets
- Spark extends the MapReduce model, supporting interactive queries and stream processing
- Spark has the ability to run computations in memory or disk (MapReduce) depending on the complexity of the problem
- Spark is designed to work on batch applications, iterative algorithms, interactive queries, and streaming.

LITTLE HISTORY OF SPARK

- Spark is open source
- Spark started in 2009 as a research project in UC Berkeley RAD Lab.
- Researchers there realised that Hadoop MapReduce was inefficient for interactive and iterative computing jobs
- Papers show that Spark is 10-20x faster than MapReduce in 2009
- In March 2010, Spark became open source
- In June 2013, Spark was accepted in the Apache Software Foundation
- Now, there are some paper claiming up to 100x faster than MapReduce

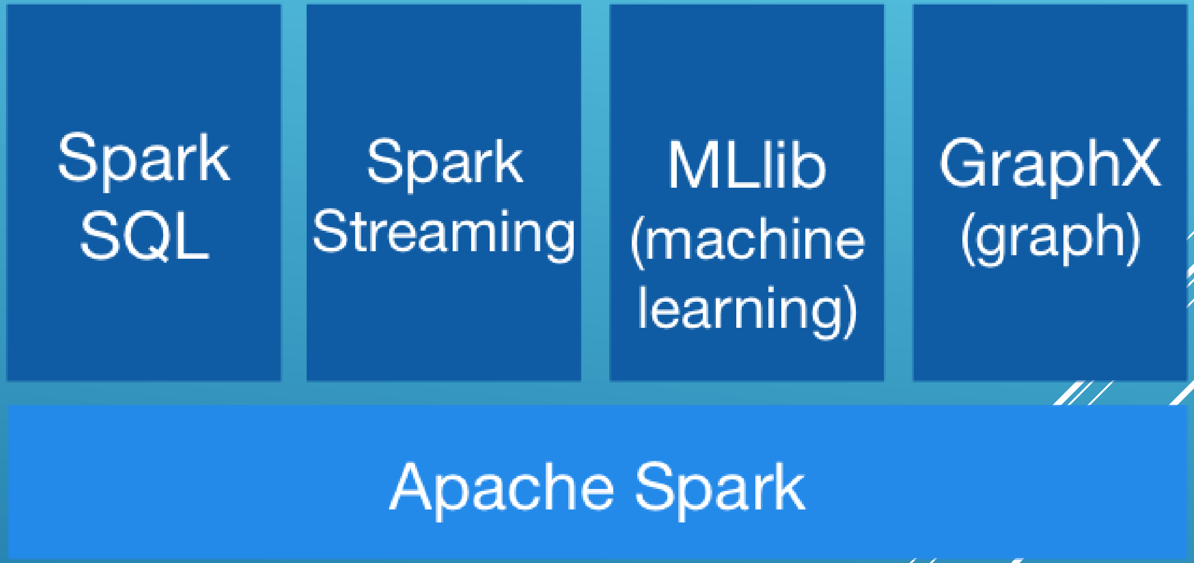
ACCESSING SPARK

- Spark is highly accessible, offering few API for
  - Python
  - Scala
  - Java
  - SQL
  - R
- Spark is written in Scala and
- Scala is written in Java, therefore Spark uses JVM
- Current Stable Version 1.6.1, coming soon 2.0.0!



SPARK LIBRARIES

- Spark SQL lets you query structured data
- Spark Streaming lets you ingest live data streams (such as Twitter data)
- MLlib is a scalable machine learning library
- GraphX is for graphs and graph-parallel computation for graph analysis (such as Facebook)



WHERE DOES IT RUN?

- Spark runs on
  - Hadoop (MapReduce Model)
  - Mesos (distributed system kernel)
  - Amazon EC2
  - Standalone (the version that we have in SHARCNET)
  - In a Cloud
- It can access diverse data sources
  - Hadoop Distributed File System (HDFS)
  - Cassandra (database)
  - HBase (Big data store and Hadoop database, also Big Table)
  - Amazon Simple Storage Service (S3)
  - MongoDB

SPARK DATA STRUCTURE

- Resilient Distributed Dataset (RDD) is the basic Spark data structure
- All work in Spark is expressed in RDDs
- RDDs are the core of Spark
- RDD is immutable distributed collection of objects
- RDDs are distributed by Spark across multiple partitions
- RDDs can contain any type of Python, Scala, Java or R objects

SPARK OPERATIONS

- Transformations: operations on RDD that return a new RDD (check the demo) such as filtering. Examples
  - Map
  - Filter
- Actions: operations that return the final value to the driver program or to the disk
  - Take
  - Collect

SPARK IS LAZY!!

- Spark uses lazy evaluation on RDD.
- Lazy evaluation means that Spark will not execute until an action
- Convenient for reading portion of data
- Loading data is also lazily evaluated! Data not loaded until it is need (an action call)

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INITIATING SPARK

- Spark uses SparkContext to connect to a Spark Cluster
- SparkContext (sc) is always initiated in the interactive mode, but not in a script
- SparkContext can be used to create RDDs on the Spark Cluster
- Only one SparkContext may be active per JVM
- SparkContext is necessary in all Spark applications.

APPLICATIONS OF SPARK

- Data Science
- Recommending Music, Movies or any product (like in Amazon or NetFlix)
- For fraud, detect network attacks using all history and machine learning
- Financial risk with Monte Carlo Simulations
- Analysing friendship (like Facebook) with GraphX
- Finding planets by means of all Kepler data
- Finding patterns in traffic from GPS data and recommend new trips

HOW TO SUBMIT A SPARK JOB

- ssh username@mosaic.sharcnet.ca
- module load python/intel/2.7.8
- module load spark
- sqsub -r time -o log_file spark-submit script.py, for a serial Python job
- sqsub -q threaded -n #CPU -r time -o log_file spark-submit script.py, for a multithreaded Python job
- spark-submit is the command used for submitting any Spark script (from Python, Scala, R, Java, SQL)

DEVELOP SPARK SCRIPT ON SHARCNET

- ssh username@mosaic.sharcnet.ca, or redfin
- ssh mos-dev1, log into the development node
- module load python/intel/2.7.8 #add this to your bashrc
- module load spark #add this to your bashrc
- pyspark   #this will start the Python interactive session
- If you prefer IPython (recommended)
- If you always want IPython, add export IPYTHON=1 to your bashrc
  - IPYTHON=1 pyspark

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WHERE TO FIND HELP IN SHARCNET?

- https://www.sharcnet.ca/help/index.php/Apache_Spark
- help@sharcnet.ca
- Or email me (jnandez@sharcnet.ca) if you want to know more about Spark

REFERENCES

- Learning Spark: Lightning-Fast Big Data Analysis By Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia
- Advanced Analytics with Spark Patterns for Learning from Data at Scala By Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills
- http://spark.apache.org/

FUNCTIONS IN SPARK

- map(function):
  - Applies a function to each element of the list
- Filter(function):
  - Applies a function to each element of the list and return only the true elements
- flatMap(function):
  - Applies a function to each element of the list and flattens the lists in an element
- reduceByKey(function):
  - Applies a function on key-value (K,V) pairs and returns a dataset of (K, V) pairs where the values for each key are aggregated using the given reduce *function*, which must be of type (lambda V1,V2 : f(V1,V2)).