Module 5: Apache Spark

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- Background in cosmology
- Staff at San Diego Supercomputer Center
- Help scientists use supercomputers
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Shortcomings of MapReduce

Learning objectives

- List the main bottlenecks of MapReduce
- Explain how Apache Spark solves them

Shortcomings of MapReduce

Force your pipeline into Map and Reduce steps

Other workflows? i.e. join, filter, map-reduce-map

Shortcomings of MapReduce

Read from disk for each MapReduce job

Iterative algorithms? i.e. machine learning

Shortcomings of MapReduce

Only native JAVA programming interface

Other languages?
Interactivity?

Solution?

- New framework: same features of MapReduce and more
- Capable of reusing Hadoop ecosystem, e.g. HDFS, YARN…
- Born at UC Berkeley

Solutions by Spark

Other workflows? i.e. join, filter, map-reduce-map

~20 highly efficient distributed operations, any combination of them

Solutions by Spark

Iterative algorithms? i.e. machine learning

in-memory caching of data, specified by the user

Solutions by Spark

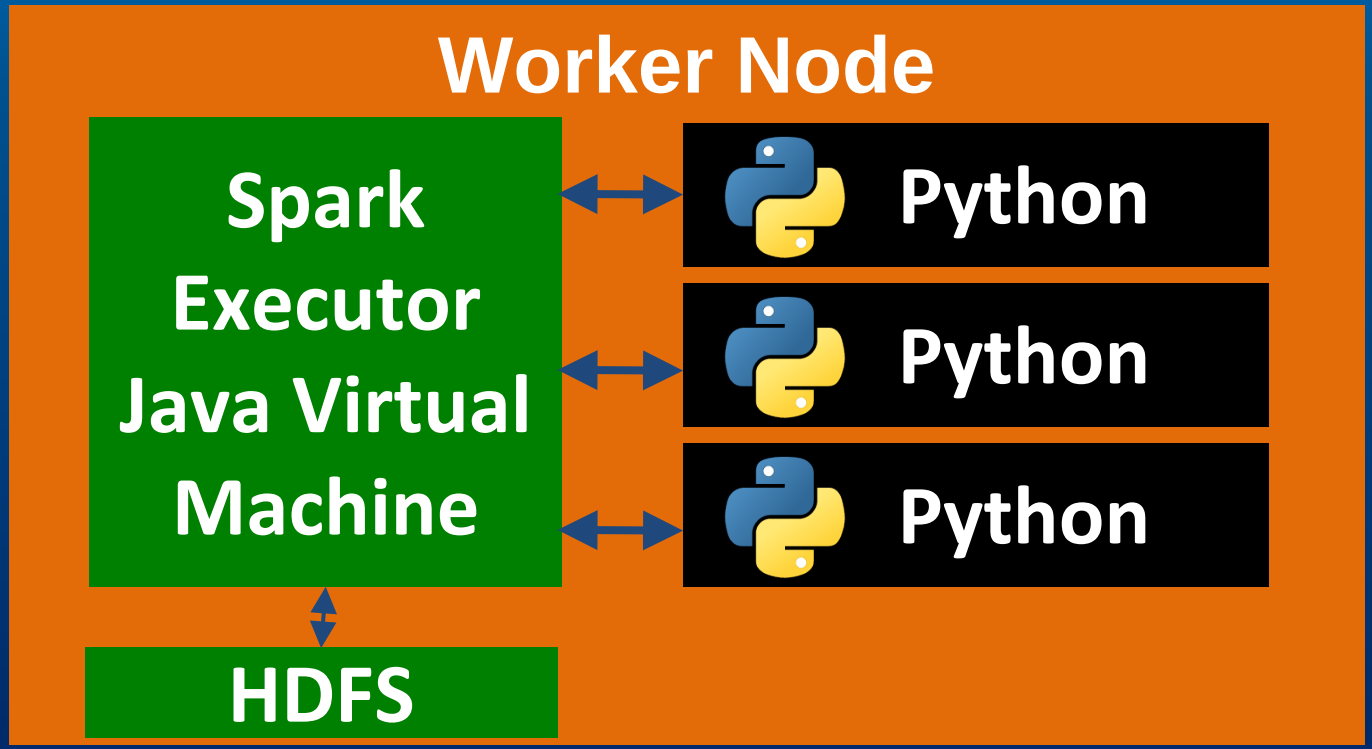
Interactivity? Other languages?

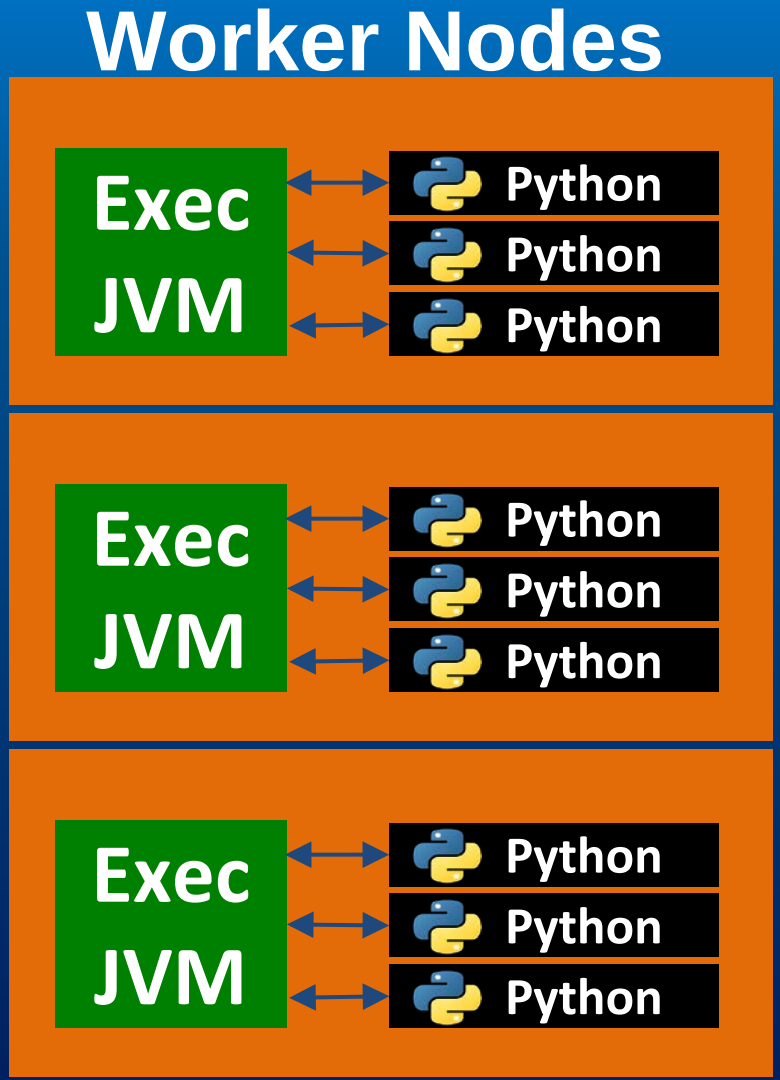
Native Python, Scala (, R) interface. Interactive shells.

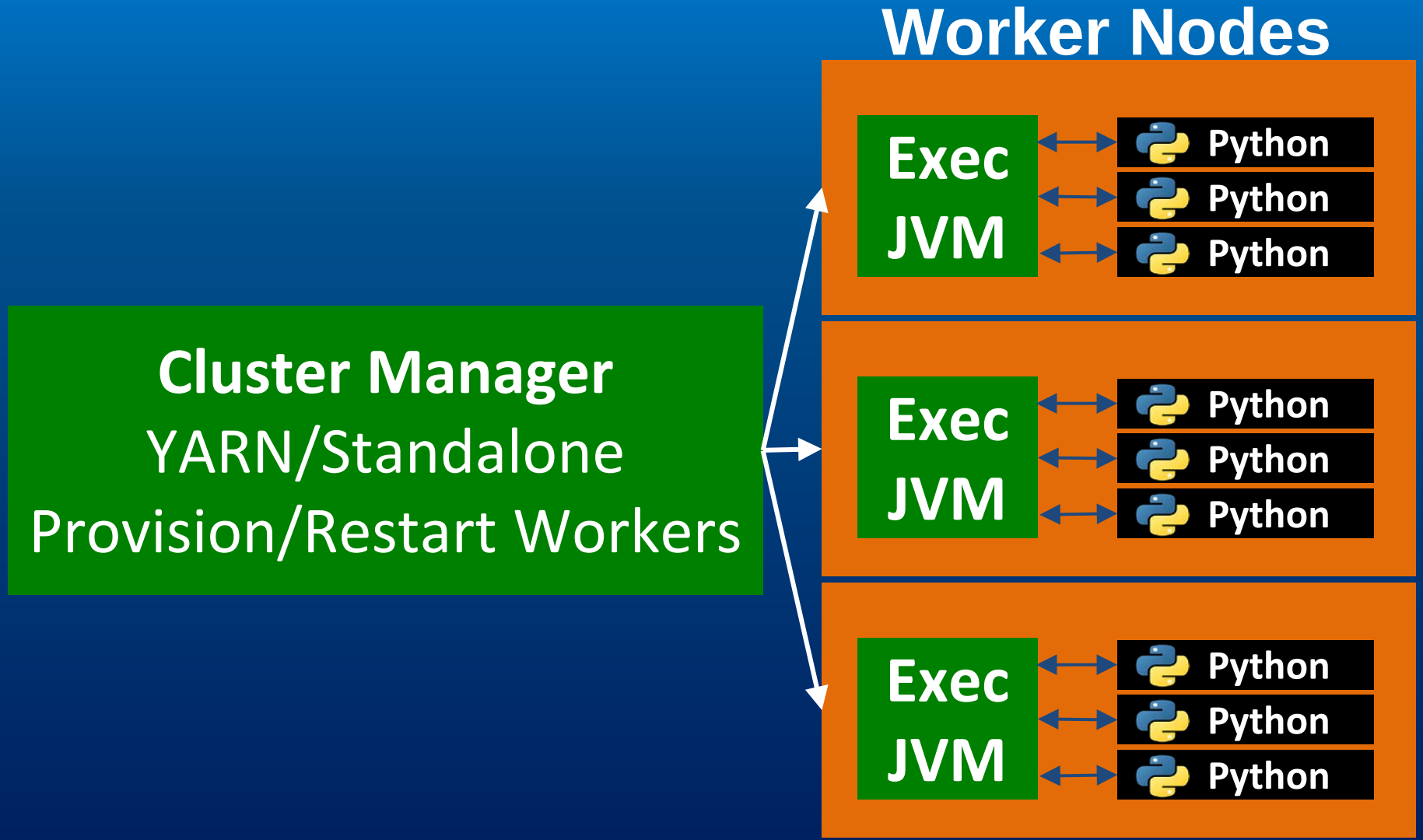
100TB Sorting competition

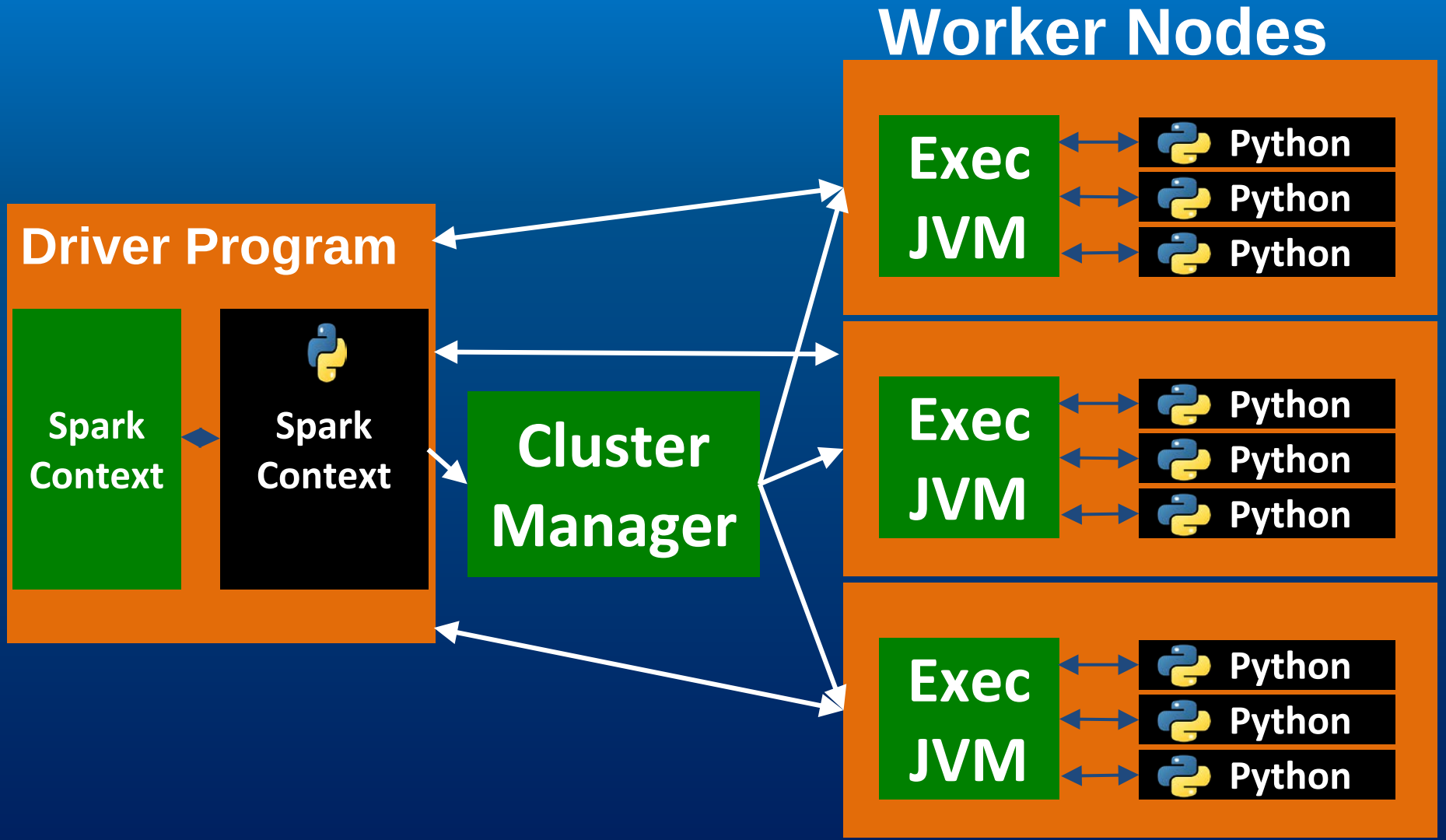
	Hadoop MR Record	Spark Record	Spark 1 PB
Data Size	102.5 TB	100 TB	1000 TB
Elapsed Time	72 mins	23 mins	234 mins
# Nodes	2100	206	190
# Cores	50400 physical	6592 virtualized	6080 virtualized
Cluster disk throughput	3150 GB/s (est.)	618 GB/s	570 GB/s
Sort Benchmark Daytona Rules	Yes	Yes	No
Network	dedicated data center, 10Gbps	virtualized (EC2) 10Gbps network	virtualized (EC2) 10Gbps network
Sort rate	**1.42 TB/min**	**4.27 TB/min**	**4.27 TB/min**
Sort rate/node	**0.67 GB/min**	**20.7 GB/min**	**22.5 GB/min**

Architecture of Spark

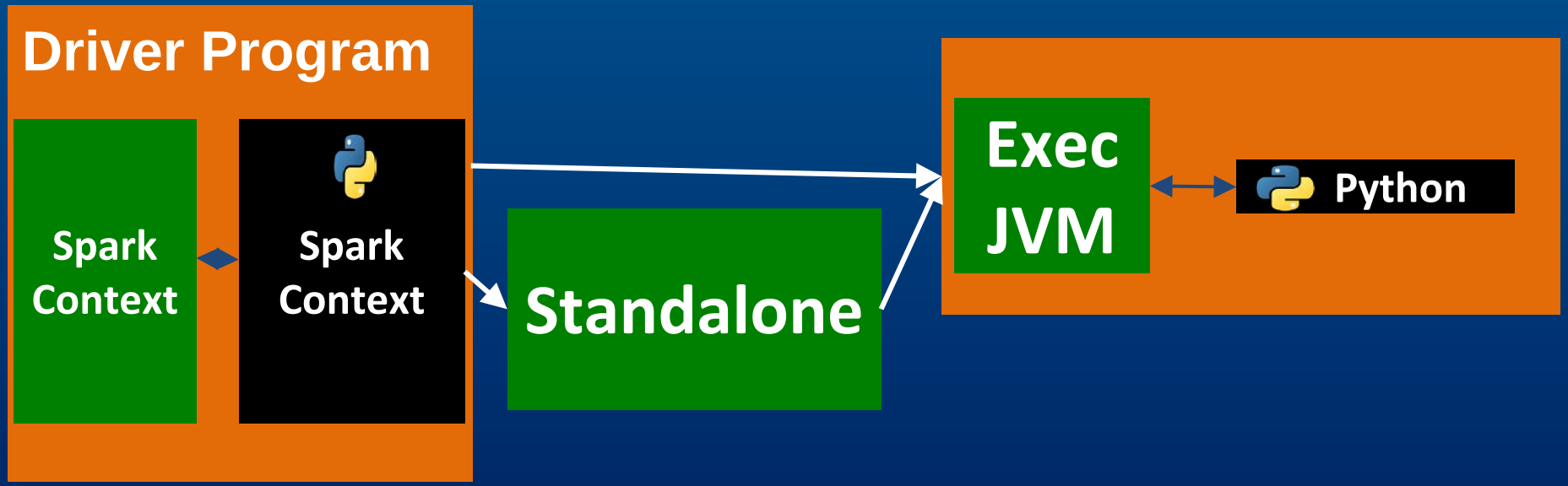

Worker Node
Spark Executor Java Virtual Machine
HDFS
Python
Python
Python


Worker Nodes
Exec
JVM
Python
Python
Python
Exec
JVM
Python
Python
Python
Exec
JVM
Python
Python
Python


Worker Nodes
Cluster Manager
YARN/Standalone
Provision/Restart Workers
Exec
JVM
Python
Python
Python
Exec
JVM
Python
Python
Python
Exec
JVM
Python
Python
Python


Worker Nodes
Driver Program
Spark Context
Spark Context
Cluster Manager
Exec JVM
Exec JVM
Exec JVM
Python
Python
Python
Python
Python
Python
Python
Python
Python

on Cloudera VM



on Amazon EMR