Introduction to pySpark

Motivation for Spark

* Data Analytics at Scale
* Existing distributed solutions (MapReduce, Dryad, etc.)
  * Pros
    * Provide primitives for parallel computations
    * Application programmers do not have to worry about work distribution or fault tolerance
  * Cons
    * Operate off of stable storage only
    * Do not have abstractions for distributed memory
    * Not suited for iterative and interactive applications
    * Do not provide a generic API using which complex data pipelines can be built

What is Spark?

Apache Spark is an open source big data processing framework built around speed, ease of use, and sophisticated analytics.

Apache Spark™ is a fast and general engine for large-scale data processing

It was originally developed in 2009 in UC Berkeley's AMPLab, and open sourced in 2010 as an **Apache** project.

What is Spark?

* Spark is a distributed compute engine which provides
  * Data-parallel computations
  * Near real-time performance
  * Fault tolerance
  * High Scalability
  * Data locality aware scheduling
  * Load balancing
* All of this on commodity hardware
* Spark provides a unified engine across data sources, workloads and environments

Benefits of Spark

Speed	Engineered from the bottom-up for performance, Spark can be 100x faster than Hadoop for large scale data processing by exploiting in memory computing and other optimizations. Spark is also fast when data is stored on disk, and currently holds the world record for large-scale on-disk sorting.

Benefits of Spark

Speed

Ease of Use

Spark has easy-to-use APIs for operating on large datasets. This includes a collection of over 100 operators for transforming data and familiar data frame APIs for manipulating semi-structured data.

Benefits of Spark

Speed

Ease of Use

A Unified Engine

Spark comes packaged with higher-level libraries, including support for SQL queries, streaming data, machine learning and graph processing. These standard libraries increase developer productivity and can be seamlessly combined to create complex workflows.

Spark Vs Hadoop

They do different things.

Hadoop and Apache Spark are both big-data frameworks, but they don't really serve the same purposes.

Hadoop distributes massive data collections across multiple nodes within a cluster of commodity servers

Spark, on the other hand, is a data-processing tool that operates on those distributed data collections; it doesn't do distributed storage

Spark Vs Hadoop

You can use one without the other.

Hadoop includes not just a storage component, known as the Hadoop Distributed File System, but also a processing component called MapReduce

You can also use Spark without Hadoop. Spark does not come with its own file management system, though, so it needs to be integrated with one -- if not HDFS, then another cloud-based data platform.

Spark was designed for Hadoop, so many agree they're better together.

Spark Vs Hadoop

Spark is speedier

Spark is generally a lot faster than MapReduce because of the way it processes data, While MapReduce operates in steps, Spark operates on the whole data set

The MapReduce workflow looks like this: read data from the cluster, perform an operation, write results to the cluster, read updated data from the cluster, perform next operation, write next results to the cluster, etc

Spark, on the other hand, completes the full data analytics operations in-memory and in near real-time: "Read data from the cluster, perform all of the requisite analytic operations, write results to the cluster, done”

Run programs up to 100x faster than Hadoop MapReduce in memory, or 10x faster on disk

Spark Vs Hadoop

You may not need Spark's speed

MapReduce's processing style can be just fine if your data operations and reporting requirements are mostly static and you can wait for batch-mode processing.

But if you need to do analytics on streaming data, like from sensors on a factory floor, or have applications that require multiple operations, you probably want to go with Spark

Most machine-learning algorithms, for example, require multiple operations. Common applications for Spark include real-time marketing campaigns, online product recommendations, cyber security analytics and machine log monitoring.

Spark Vs Hadoop

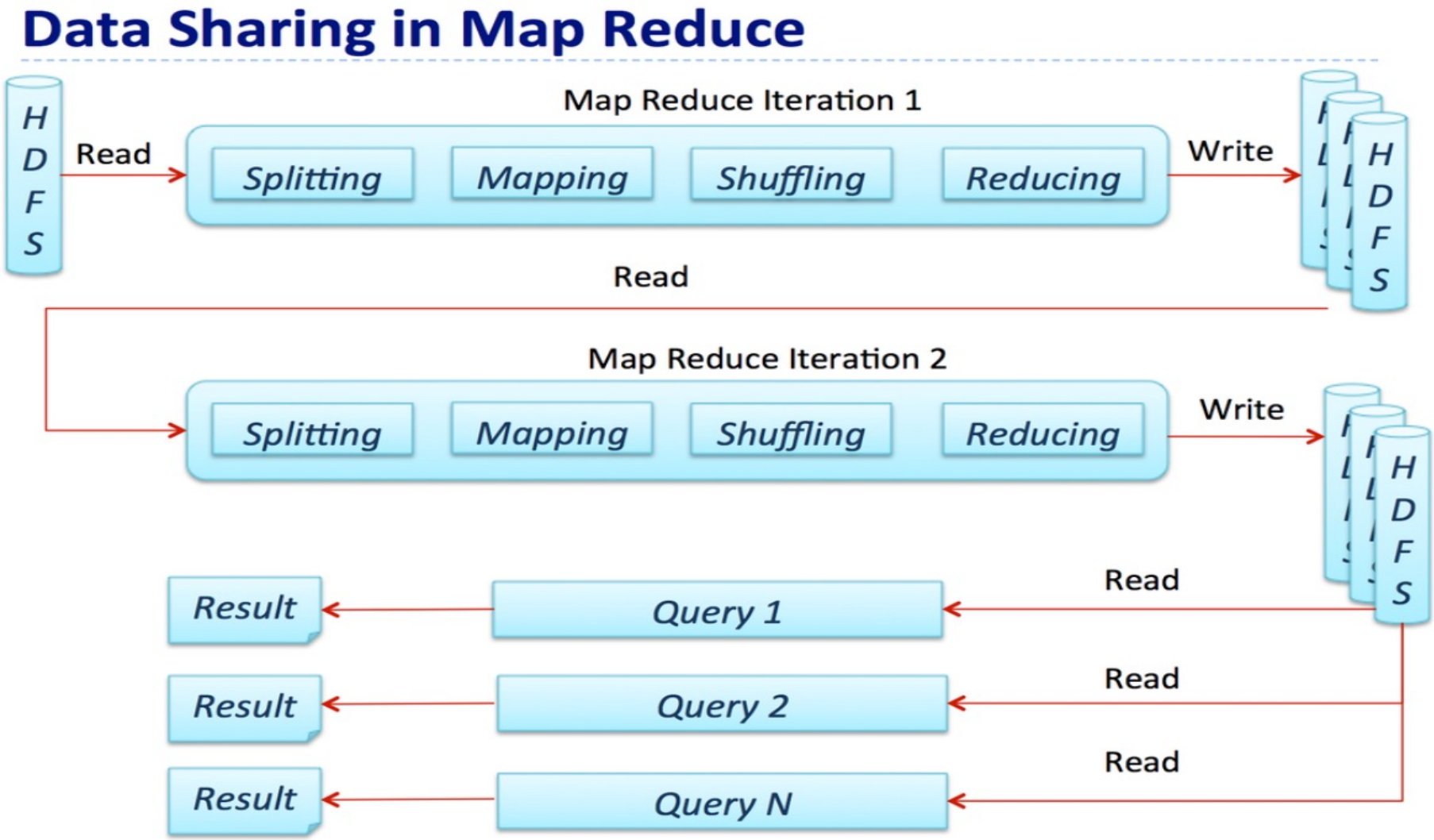
Failure recovery: different, but still good

Hadoop is naturally resilient to system faults or failures since data is written to disk after every operation,

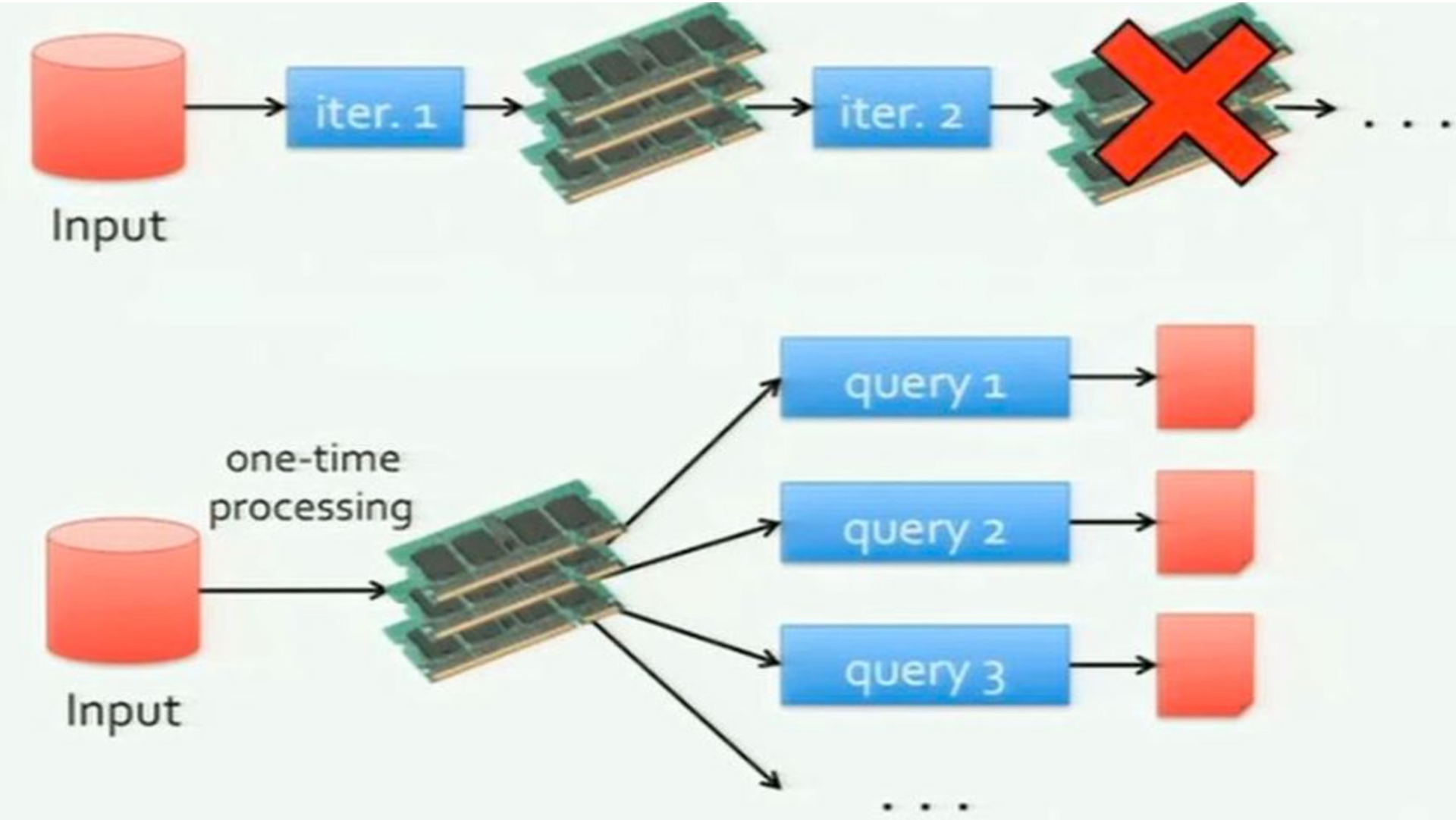
but Spark has similar built-in resiliency by virtue of the fact that its data objects are stored in something called resilient distributed datasets distributed across the data cluster.

These data objects can be stored in memory or on disks, and RDD provides full recovery from faults or failures

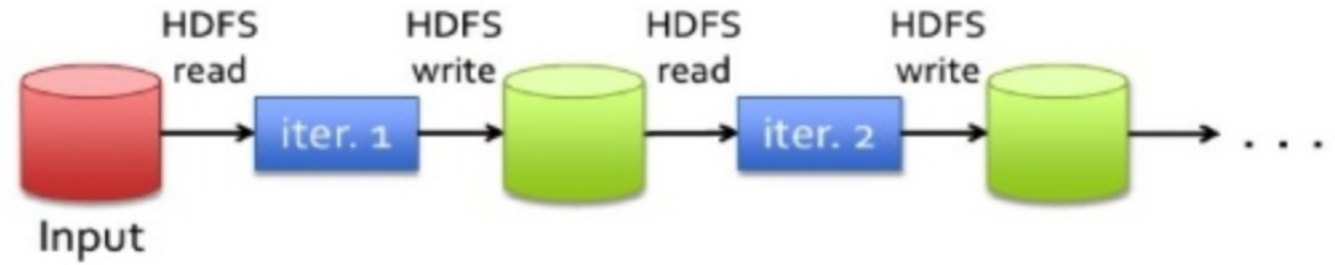
Data Sharing in Map-Reduce

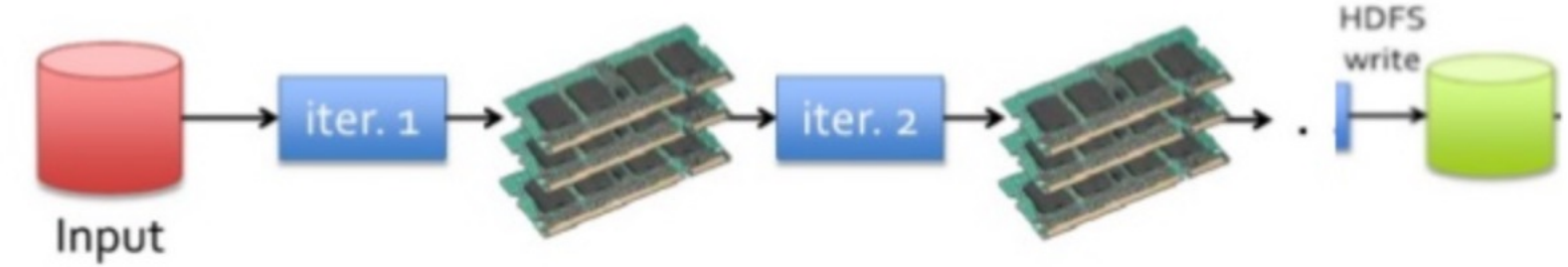


Spark Iterative Processing



Spark vs. Hadoop Map Reduce





Spark vs. Hadoop Map Reduce

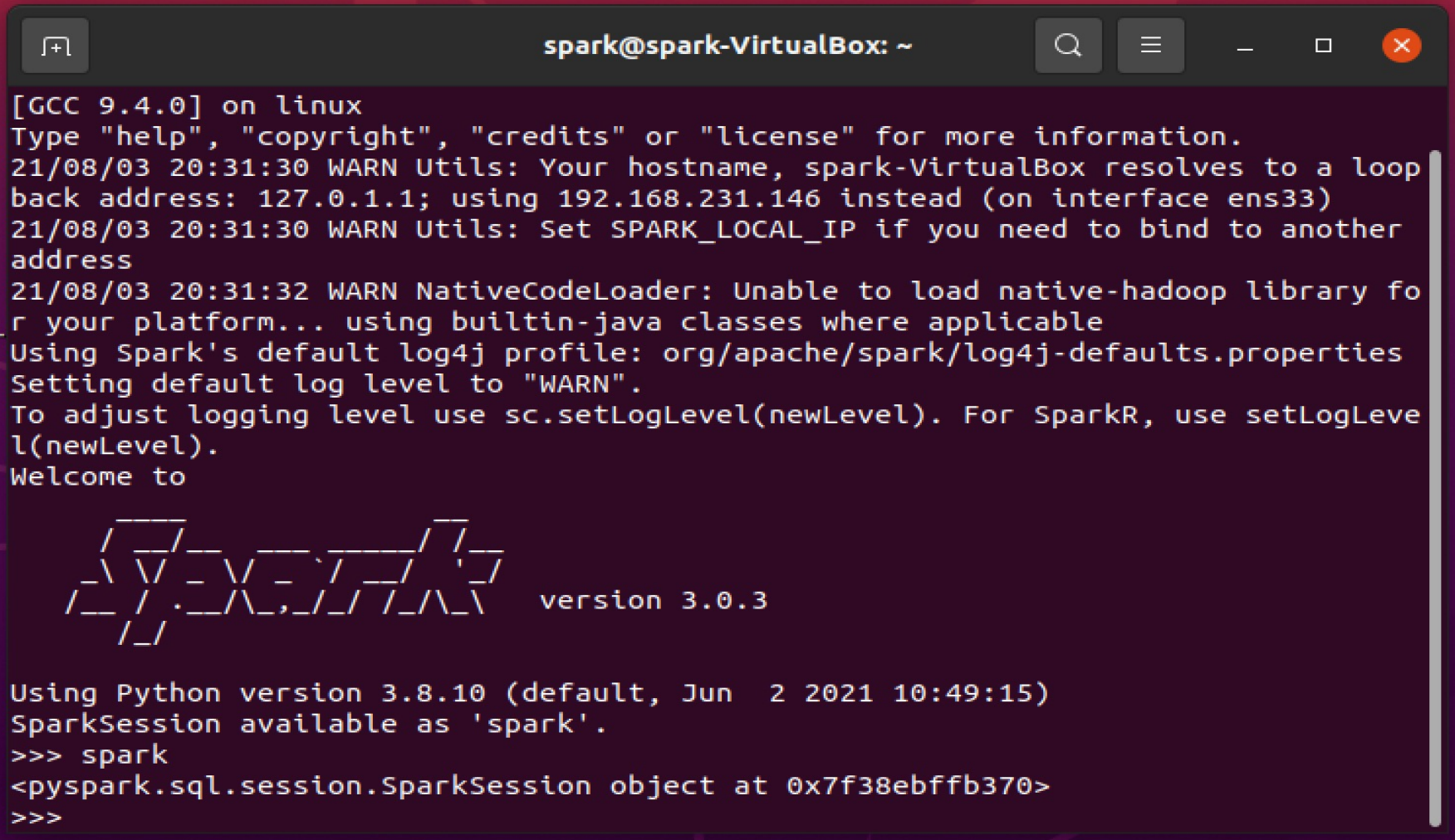
* More generic API
  * Variety of operations – not limited to Map and Reduce
  * Built-in libraries for SQL, Graph Processing and Machine Learning
  * Unified API for batch and streaming analytics
* More efficient runtime
  * In-memory processing
  * Long living workers
  * More efficient scheduling
  * Highly efficient shuffle
  * No fixed slot types

Spark Use cases

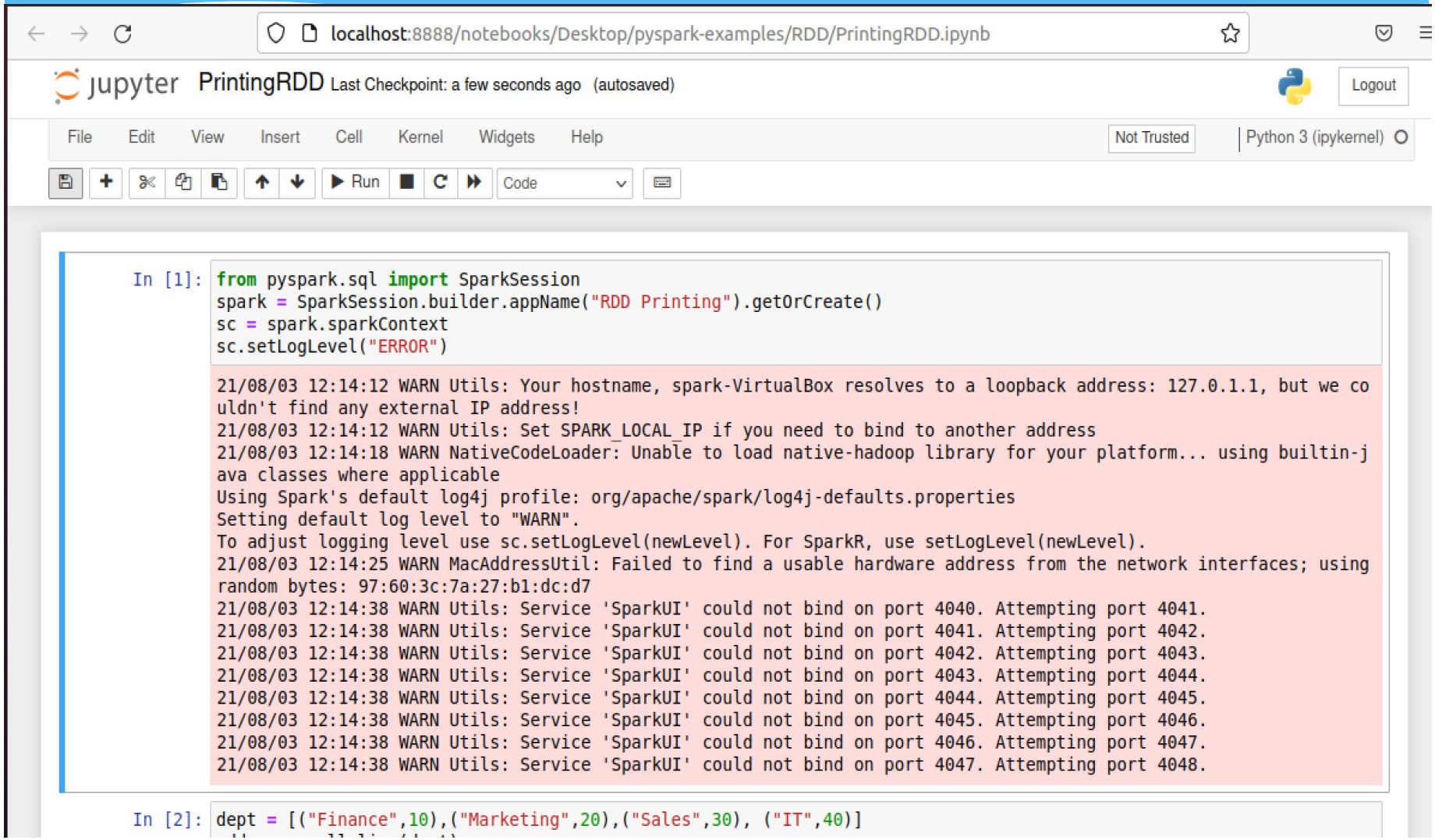
applications	sensors	web	mobile phones
intrusion detection	malfunction detection	site analytics	network metrics analysis
fraud detection	dynamic process optimisation	recommendations	location based ads
log processing	supply chain planning	sentiment analysis	...

Spark Users and Distributors

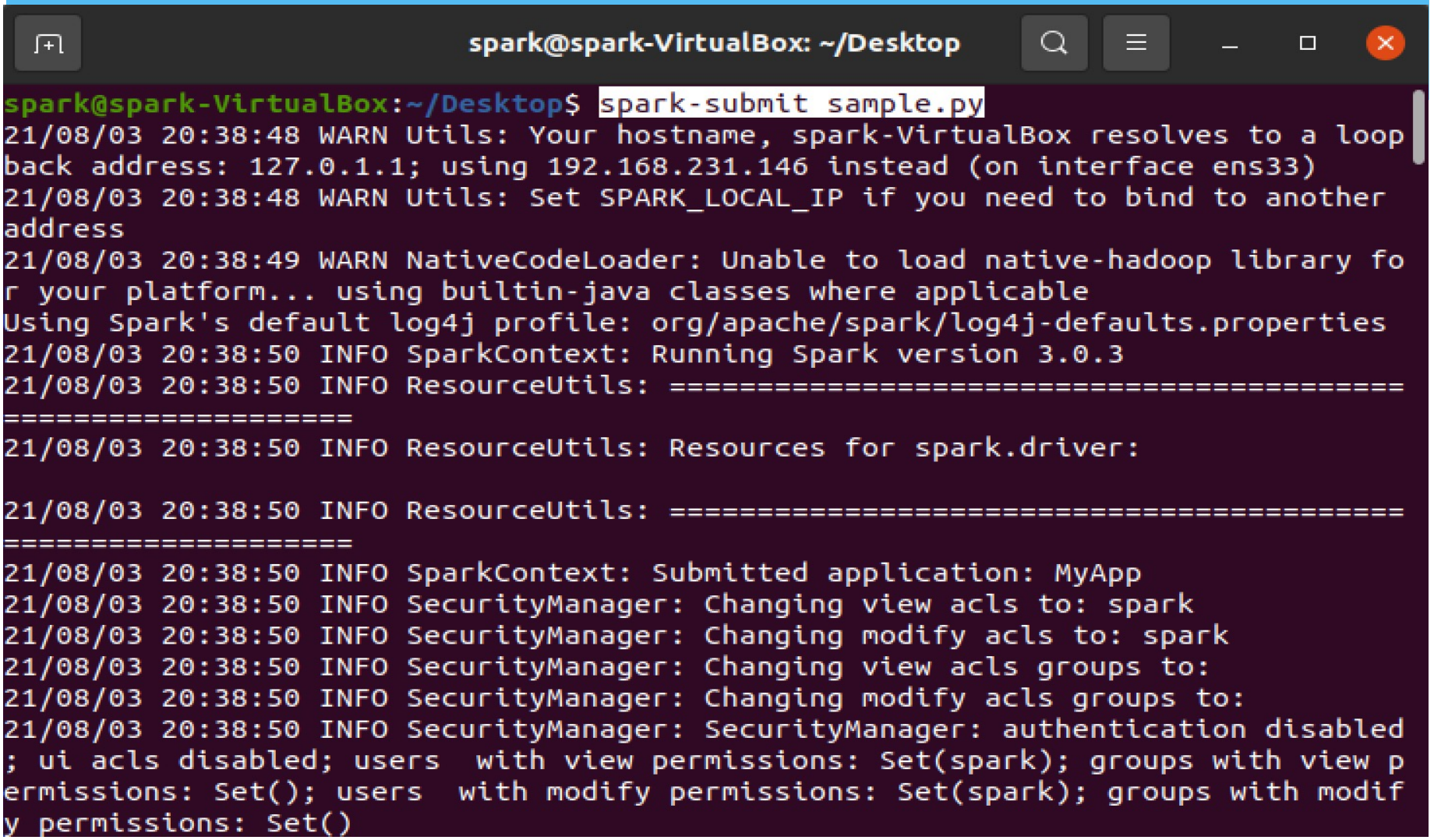
Spark Execution Environment pyspark terminal



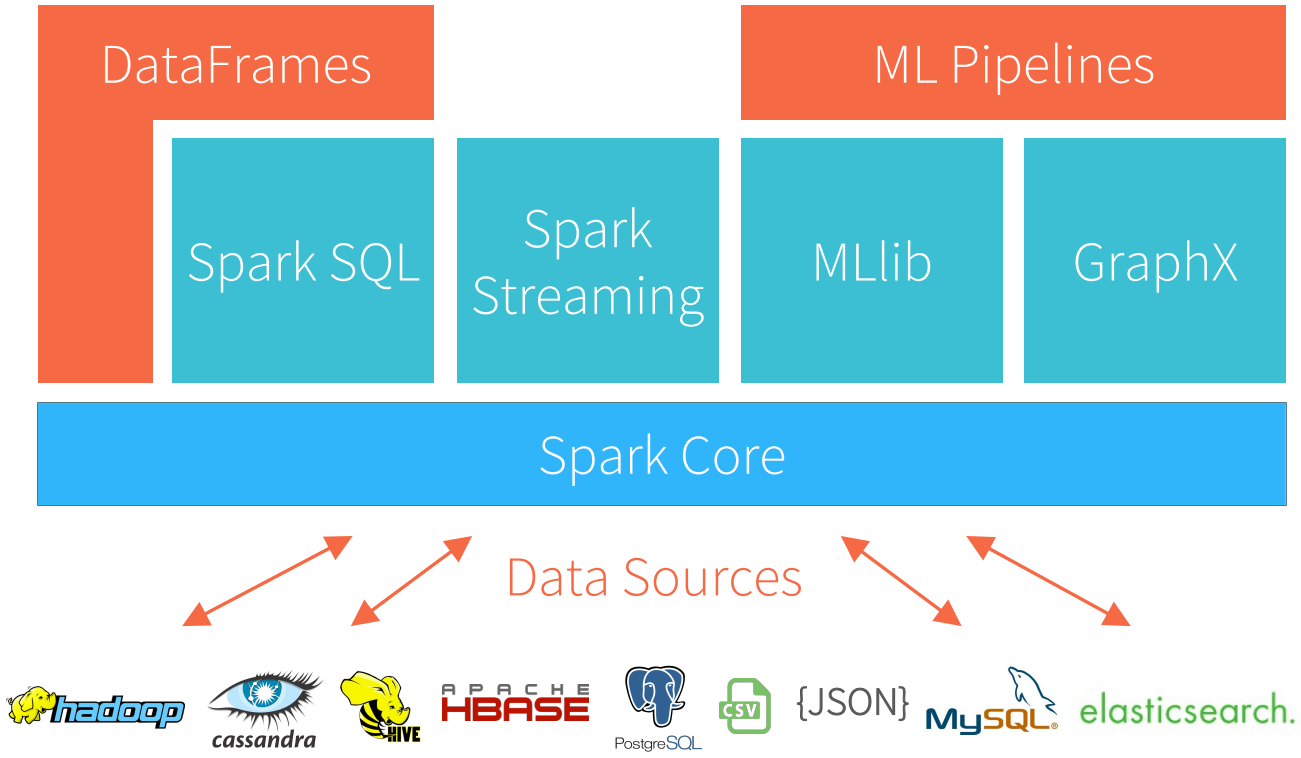
Spark Execution Environment
Jupyter Notebooks



Spark Execution Environment
By script



Spark – Eco system



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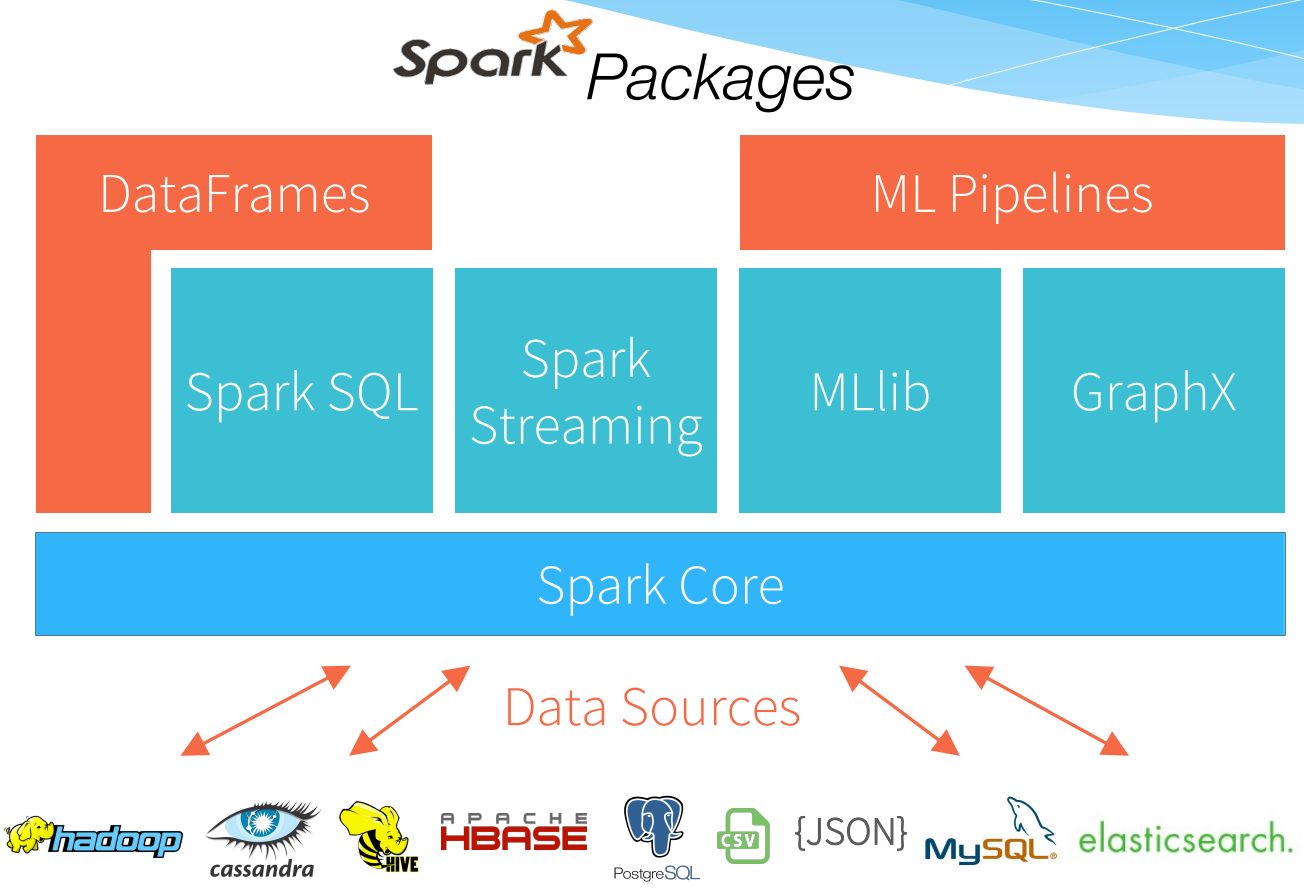
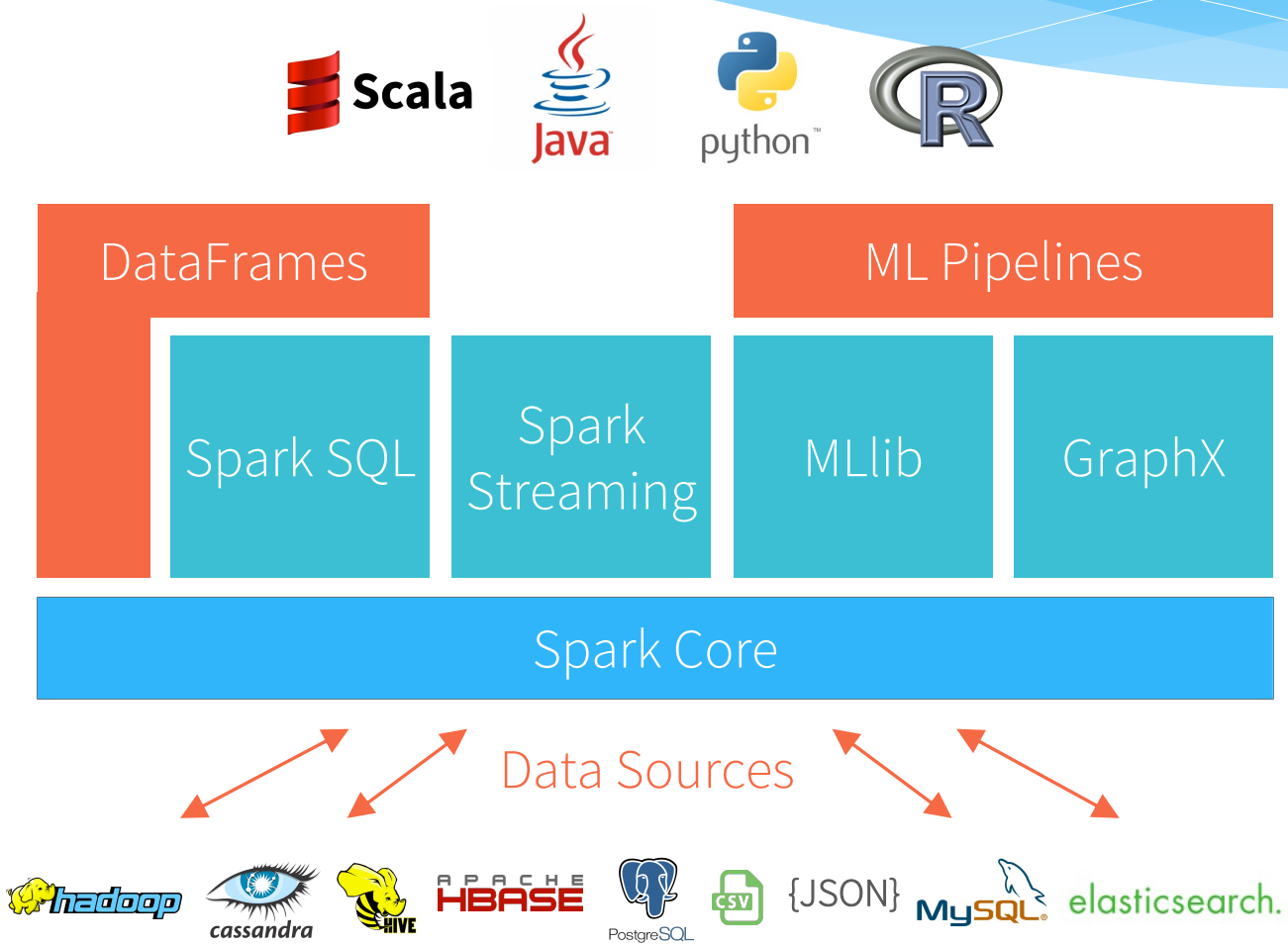


Spark - Eco system



100TB Daytona Sort Competition 2014

Spark sorted the same data **3X faster** using **10X fewer machines** than Hadoop MapReduce in 2013.

	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**

More info:

http://sortbenchmark.org

http://databricks.com/blog/2014/11/05/spark-officially-sets-a-new-record-in-large-scale-sorting.html

Spark Resources

* http://spark.apache.org
  * OSS Spark release information, downloads, documentation, etc.
* https://databricks.com/blog
  * Spark committer blogs
* https://sparkhub.databricks.com/
  * Spark community site
* http://spark-packages.org/
  * Community index of packages for Spark
* http://blog.cloudera.com/blog/category/spark/
  * Cloudera's blogs on Spark