

Introduction to Spark



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Preface

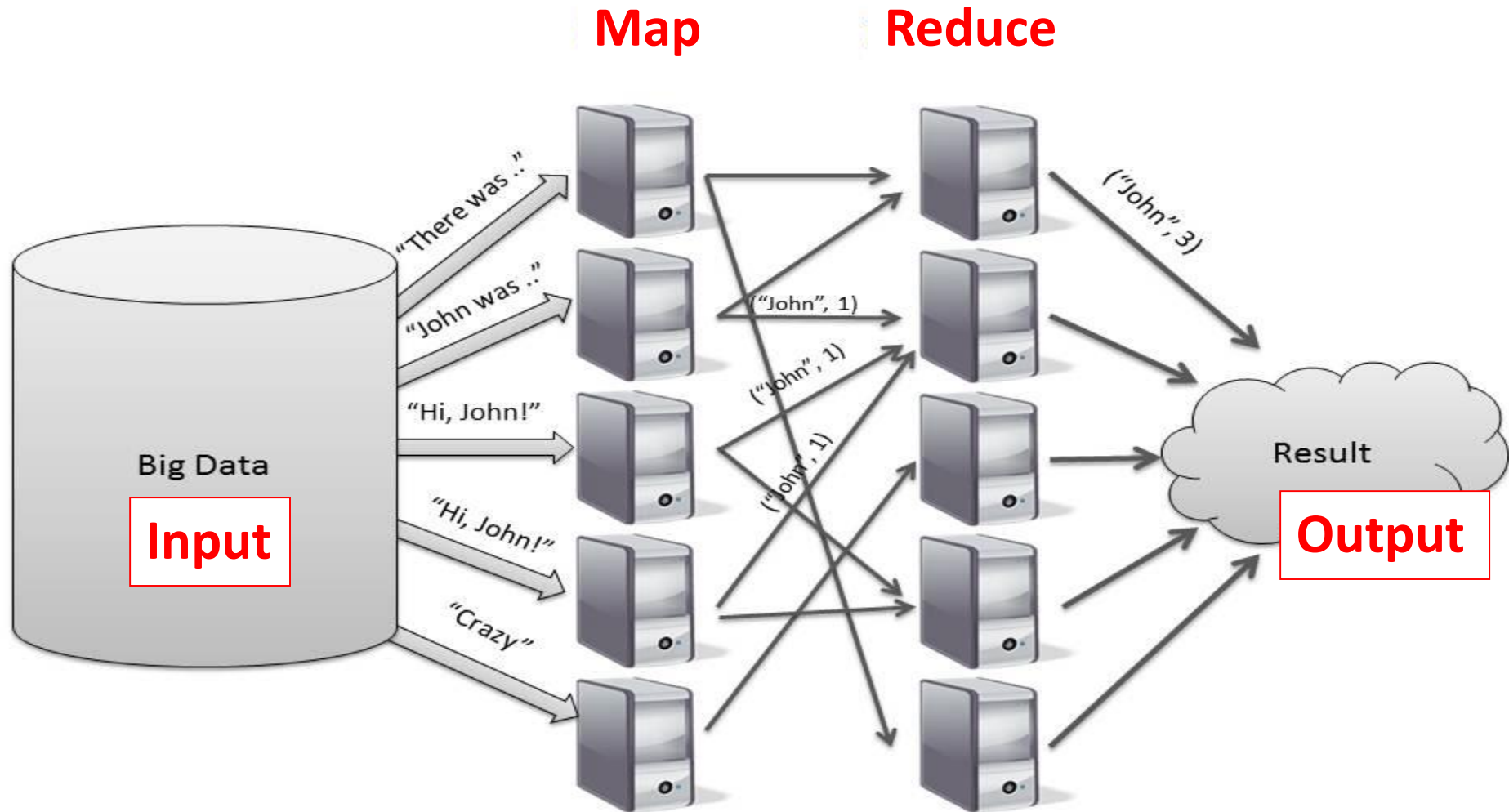
Content of this Lecture:

- In this lecture, we will discuss the '**framework of spark**', Resilient Distributed Datasets (RDDs) and also discuss Spark execution.

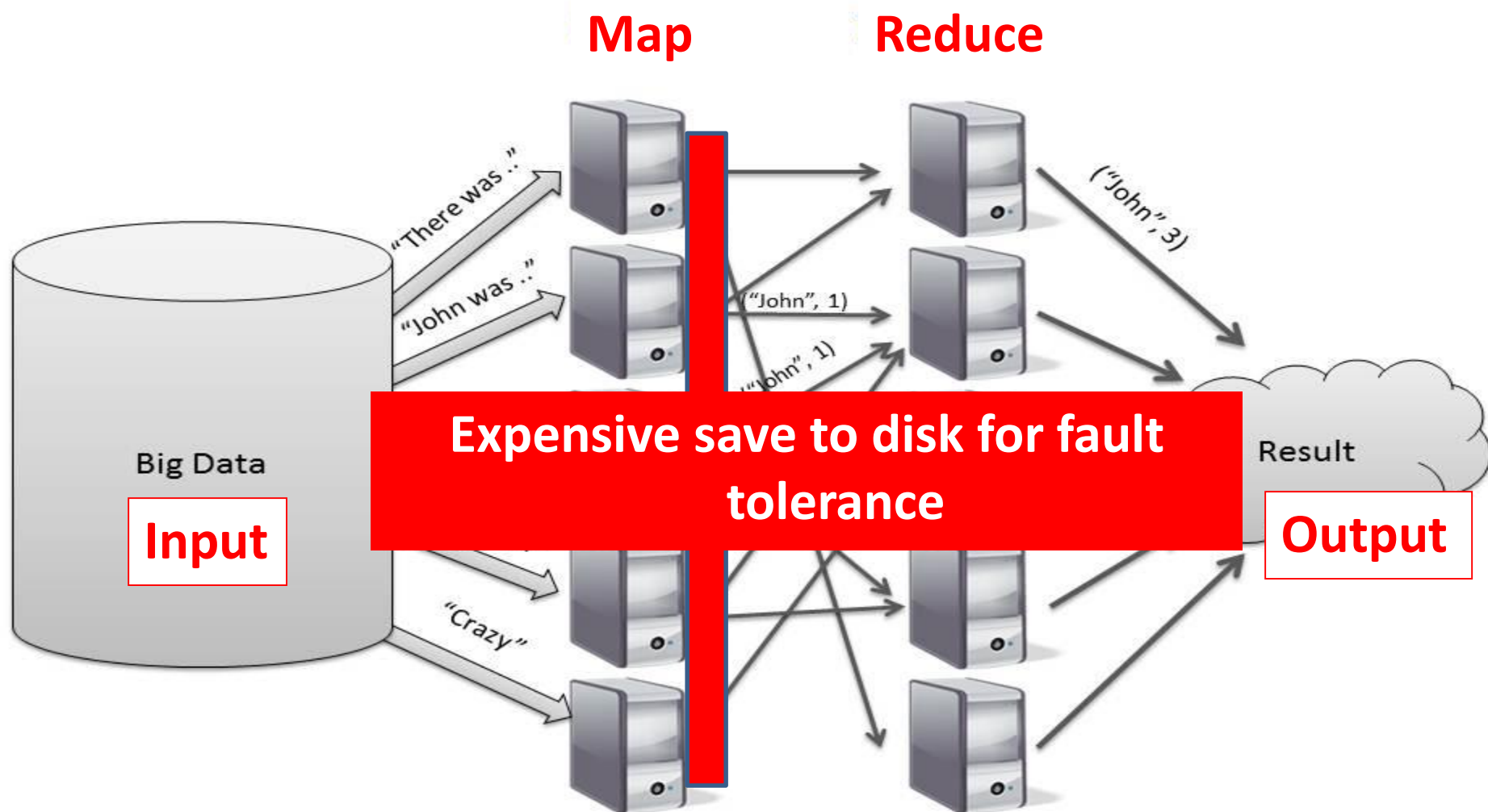
Need of Spark

- **Apache Spark** is a big data analytics framework that was originally developed at the University of California, Berkeley's AMPLab, in 2012. Since then, it has gained a lot of attraction both in academia and in industry.
- It is an another system for big data analytics
- **Isn't MapReduce good enough?**
 - Simplifies batch processing on large commodity clusters

Need of Spark



Need of Spark



Need of Spark

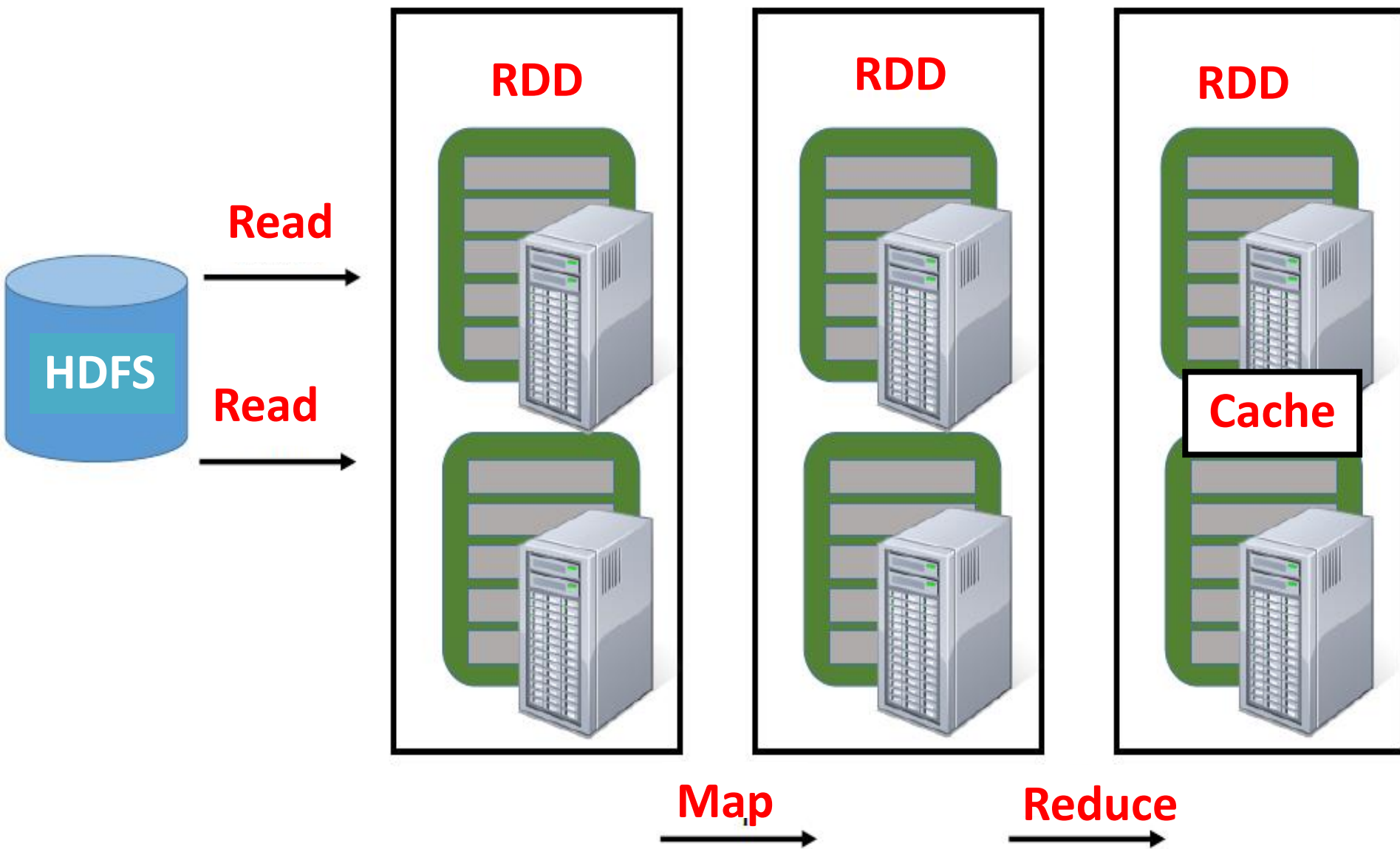
- MapReduce can be expensive for some applications e.g.,
 - **Iterative**
 - **Interactive**
- Lacks efficient data sharing
- Specialized frameworks did evolve for different programming models
 - **Bulk Synchronous Processing (Pregel)**
 - **Iterative MapReduce (Hadoop)**

Solution: Resilient Distributed Datasets (RDDs)

Resilient Distributed Datasets (RDDs)

- Immutable, partitioned collection of records
- Built through coarse grained transformations (map, join ...)
- Can be cached for efficient reuse

Need of Spark



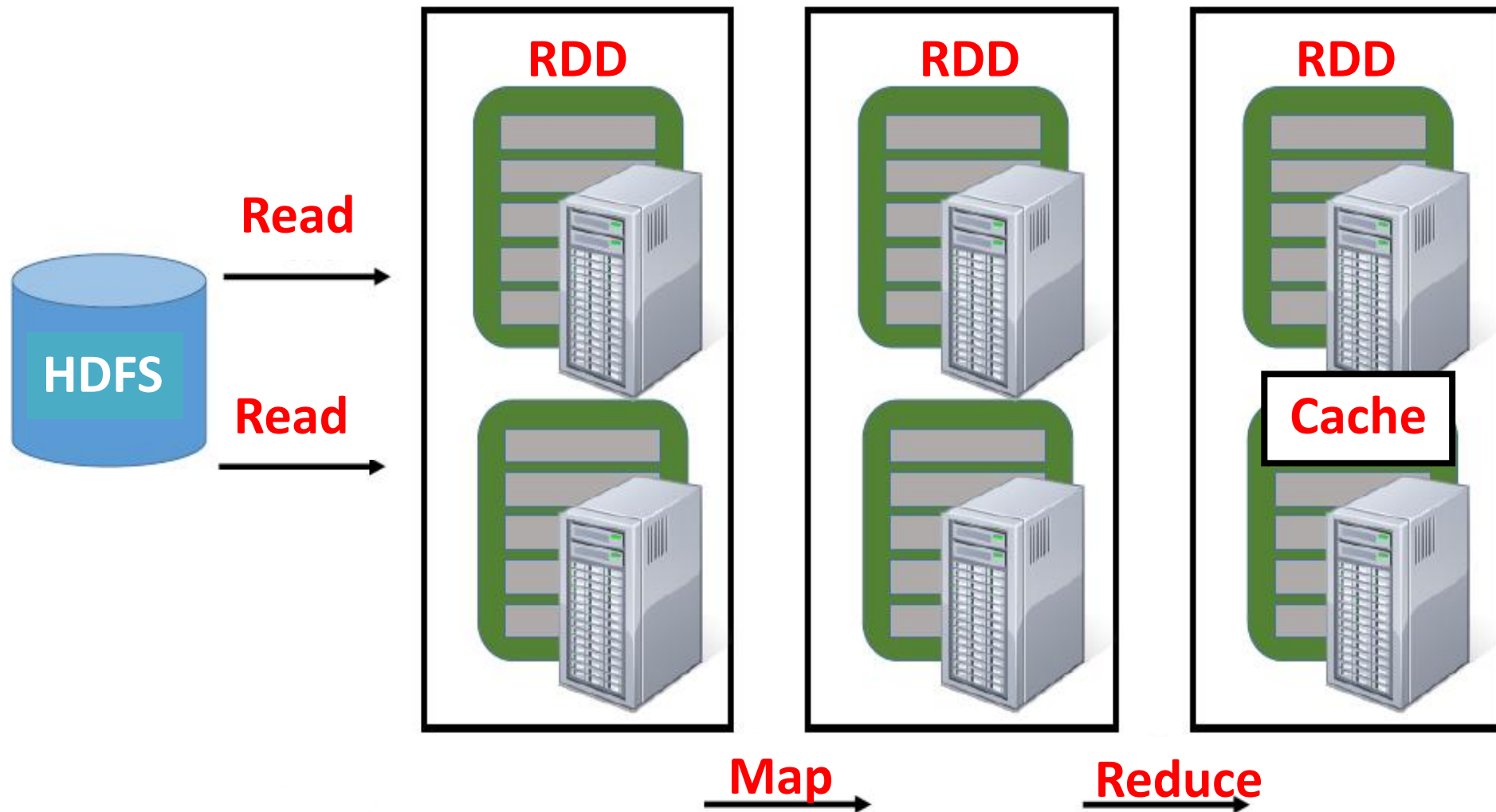
Solution: Resilient Distributed Datasets (RDDs)

Resilient Distributed Datasets (RDDs)

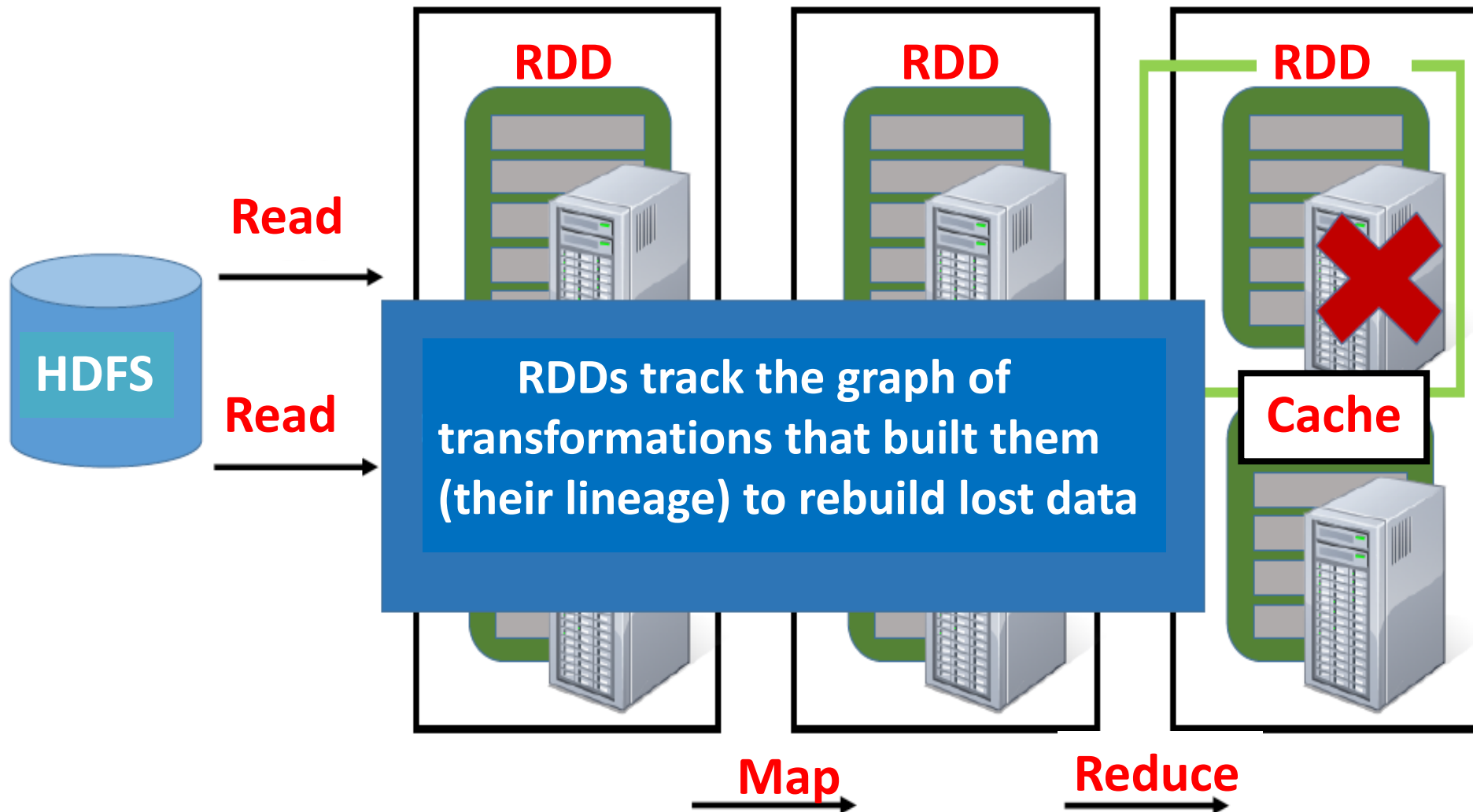
- Immutable, partitioned collection of records
- Built through coarse grained transformations (map, join ...)

Fault Recovery?

- Lineage!
 - Log the coarse grained operation applied to a partitioned dataset
 - Simply recompute the lost partition if failure occurs!
 - No cost if no failure







What can you do with Spark?

- **RDD operations**

- Transformations e.g., filter, join, map, group-by ...
- Actions e.g., count, print ...

- **Control**

- **Partitioning:** Spark also gives you control over how you can partition your RDDs.
- **Persistence:** Allows you to choose whether you want to persist RDD onto disk or not.

Spark Applications

- i. **Twitter spam classification**
- ii. **EM algorithm for traffic prediction**
- iii. **K-means clustering**
- iv. **Alternating Least Squares matrix factorization**
- v. **In-memory OLAP aggregation on Hive data**
- vi. **SQL on Spark**

Reading Material

- Matei Zaharia, Mosharaf Chowdhury, Michael J. Franklin, Scott Shenker, Ion Stoica

“Spark: Cluster Computing with Working Sets”

- Matei Zaharia, Mosharaf Chowdhury et al.

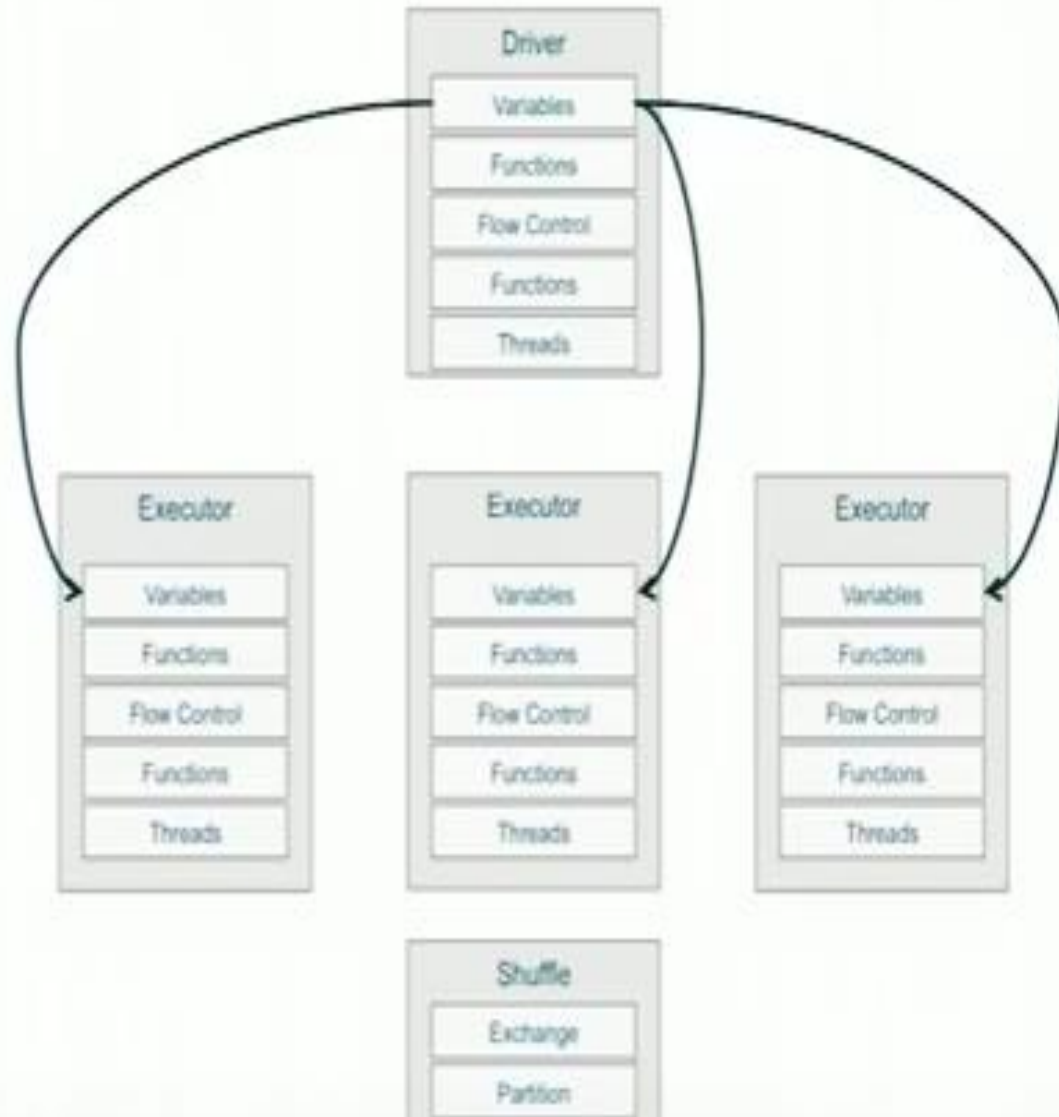
“Resilient Distributed Datasets: A Fault-Tolerant Abstraction for In-Memory Cluster Computing”

<https://spark.apache.org/>



Spark Execution

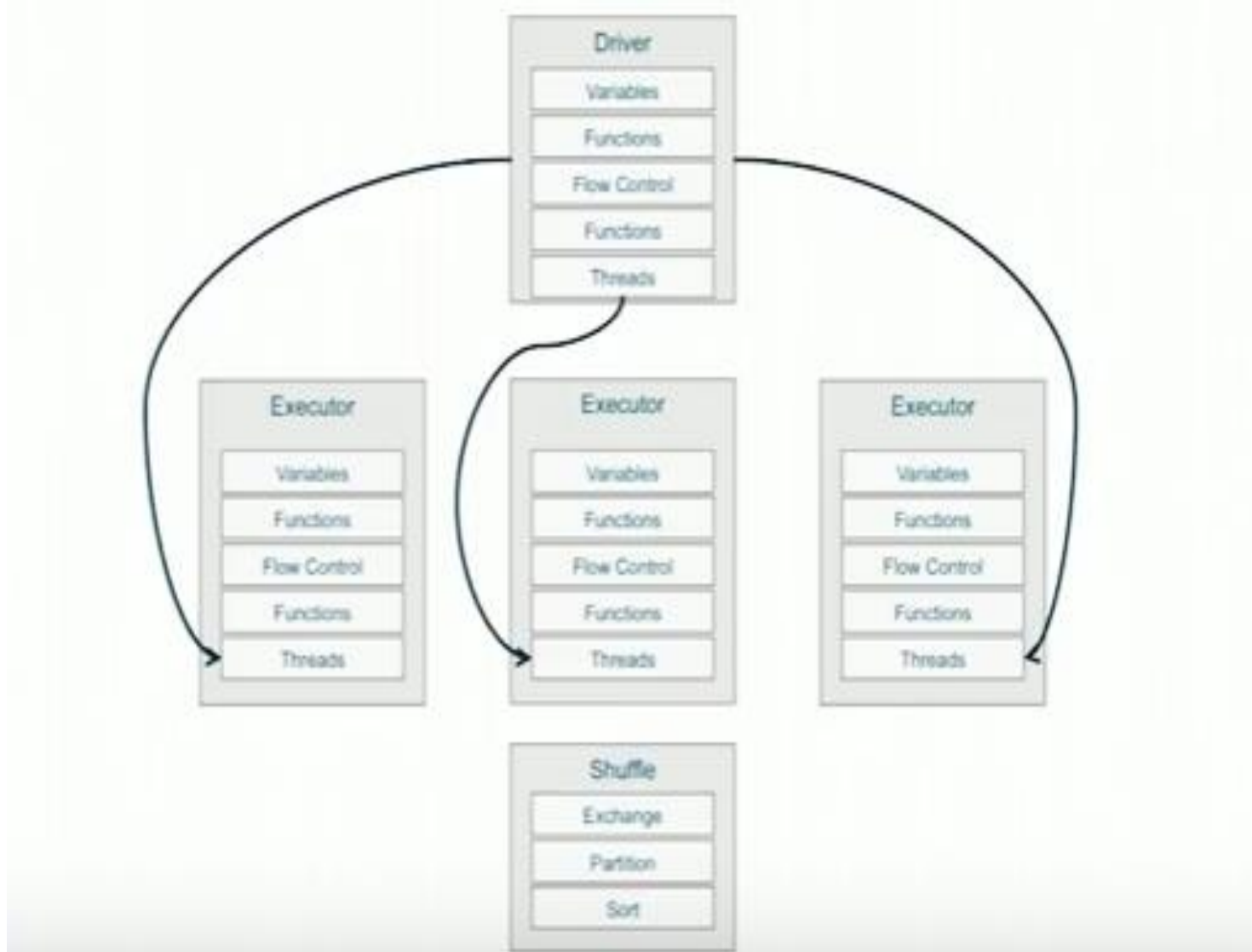
Distributed Programming (Broadcast)



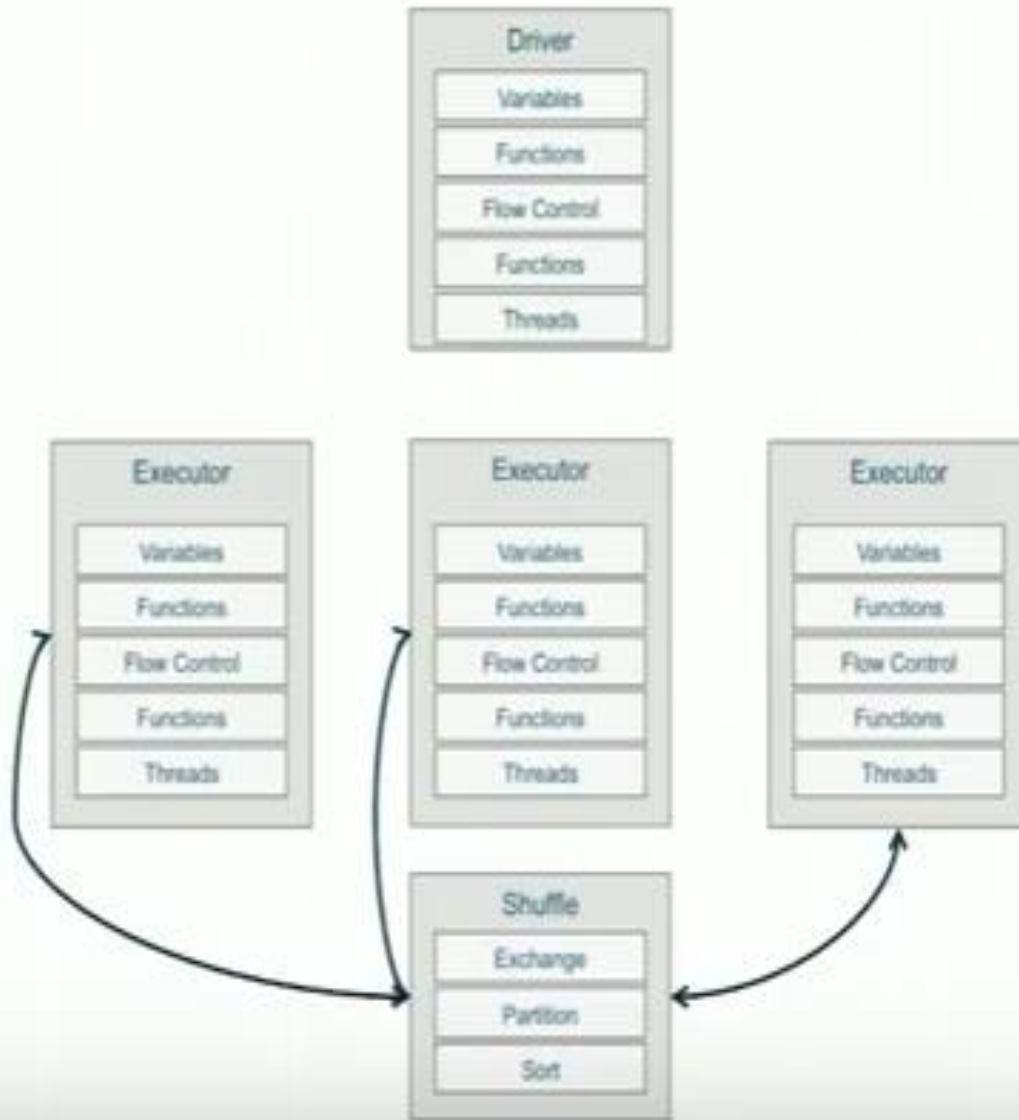
Distributed Programming (Take)



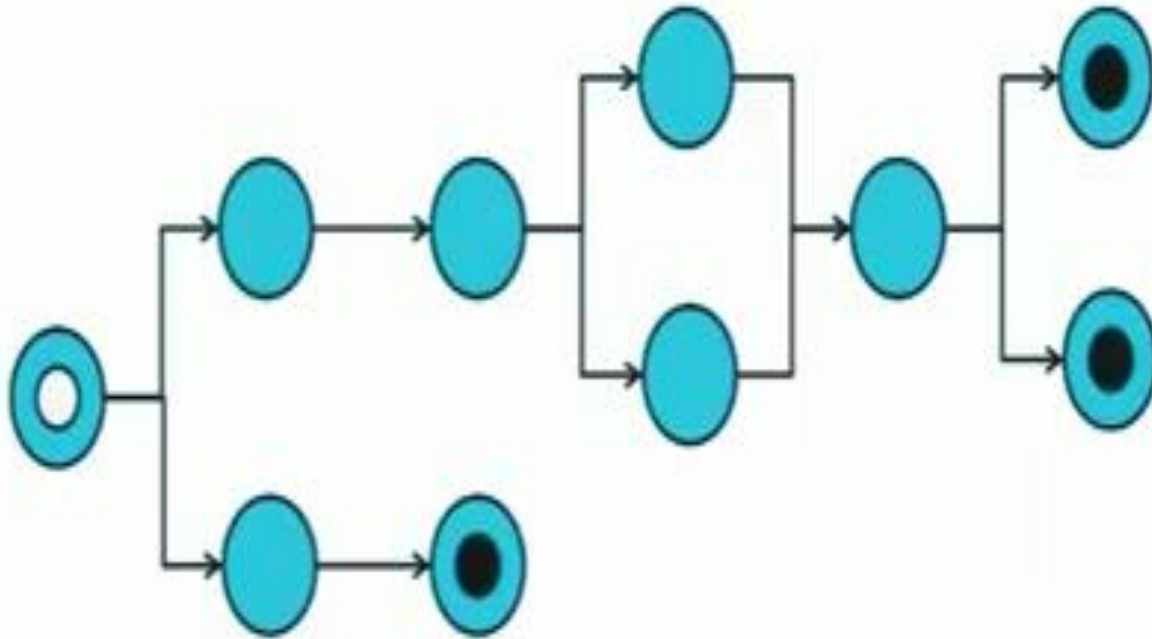
Distributed Programming (DAG Action)



Distributed Programming (Shuffle)



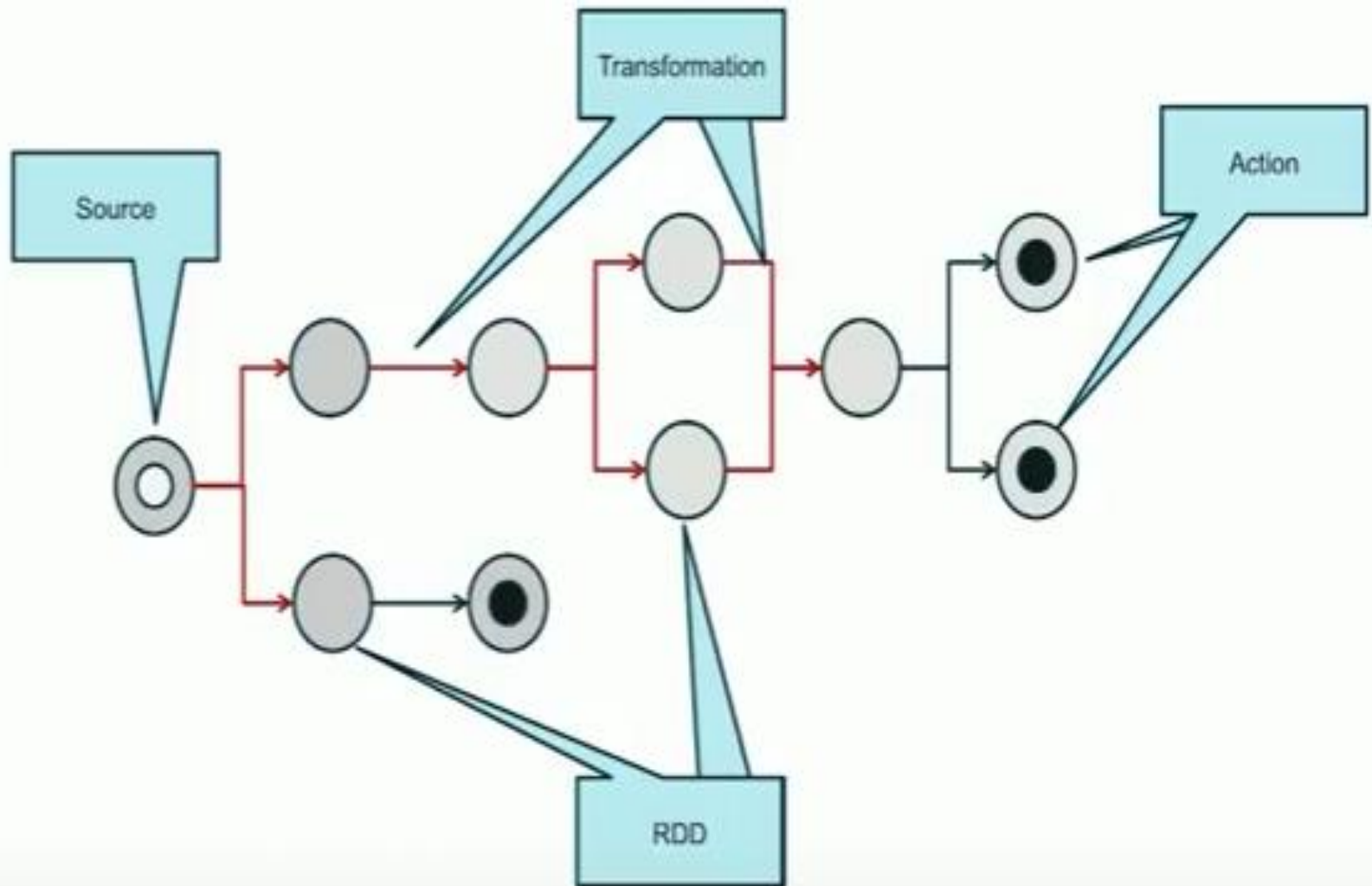
DAG (Directed Acyclic Graph)



DAG (Directed Acyclic Graph)

- **Action**
 - Count
 - Take
 - Foreach
- **Transformation**
 - Map
 - ReduceByKey
 - GroupByKey
 - JoinByKey

DAG (Directed Acyclic Graph)



Flume Java

```
1. val conf = new SparkConf().setMaster("local[2]")
2. val sc = new SparkContext(conf)
3. val lines = sc.textFile(path, 2)
4. val words = lines.flatMap(_.split(" "))
5. val pairs = words.map(word => (word, 1))
6. val wordCounts = pairs.reduceByKey(_ + _)
7. val localValues = wordCounts.take(100)
8. localValues.foreach(r => println(r))
```


Spark Implementation

Spark ideas

- Expressive computing system, not limited to map-reduce model
- Facilitate system memory
 - avoid saving intermediate results to disk
 - cache data for repetitive queries (e.g. for machine learning)
- Compatible with Hadoop

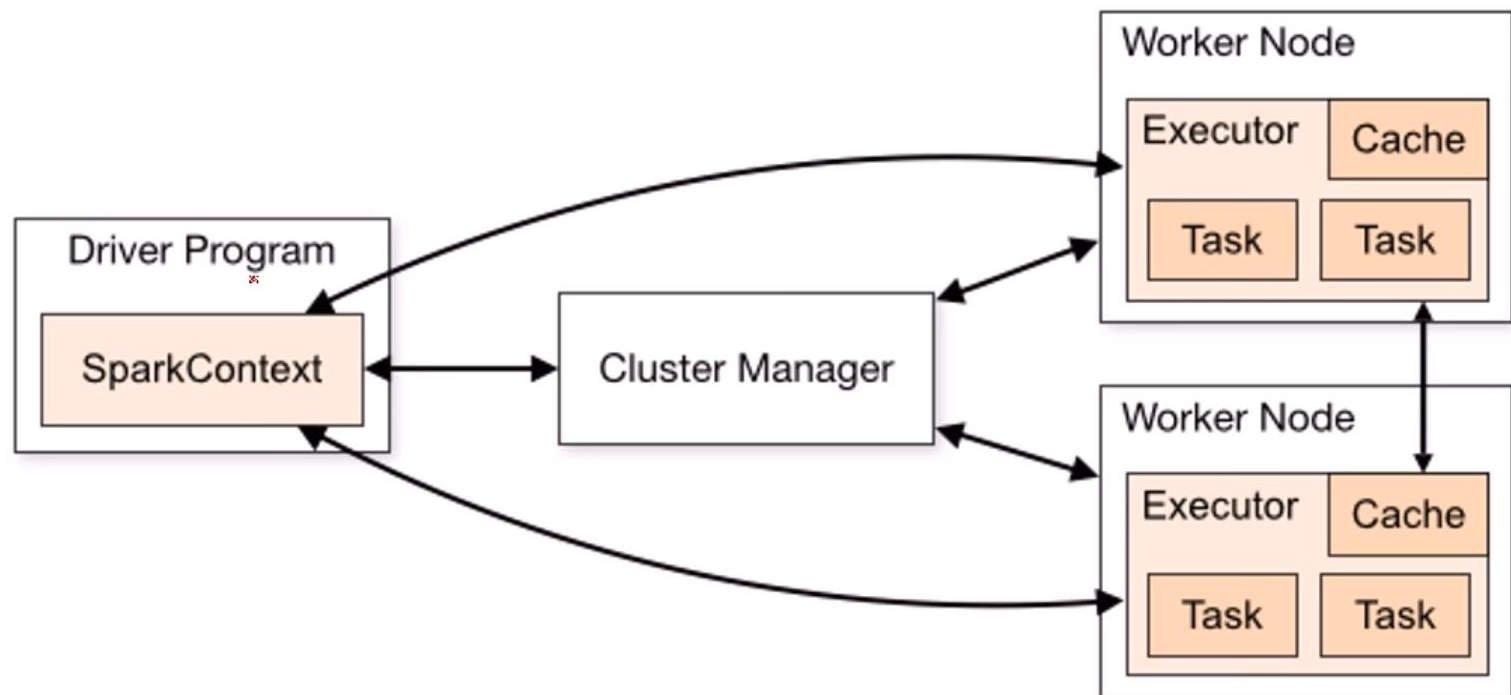
RDD abstraction

- Resilient Distributed Datasets
- Partitioned collection of records
- Spread across the cluster
- Read-only
- Caching dataset in memory
 - different storage levels available
 - fallback to disk possible

RDD operations

- *Transformations* to build RDDs through deterministic operations on other RDDs
 - transformations include *map, filter, join*
 - lazy operation
- *Actions* to return value or export data
 - actions include *count, collect, save*
 - triggers execution

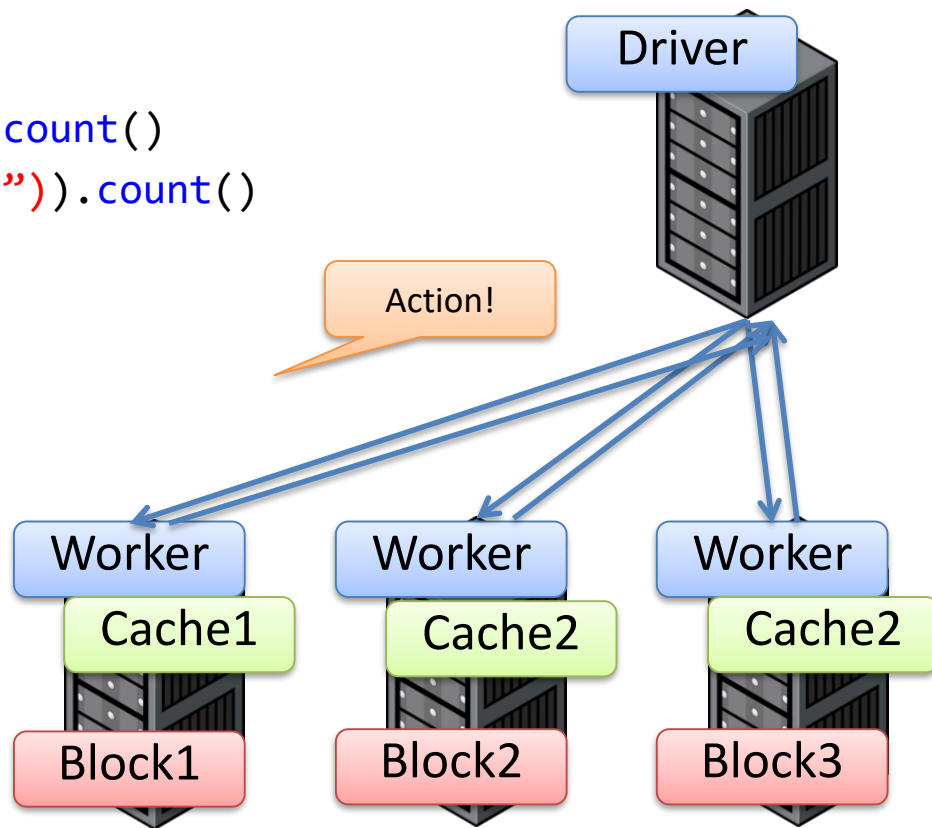
Spark Components



Job example

```
val log = sc.textFile("hdfs://...")  
val errors = file.filter(_.contains("ERROR"))  
errors.cache()
```

```
errors.filter(_.contains("I/O")).count()  
errors.filter(_.contains("timeout")).count()
```



RDD partition-level view

Dataset-level view:

log:

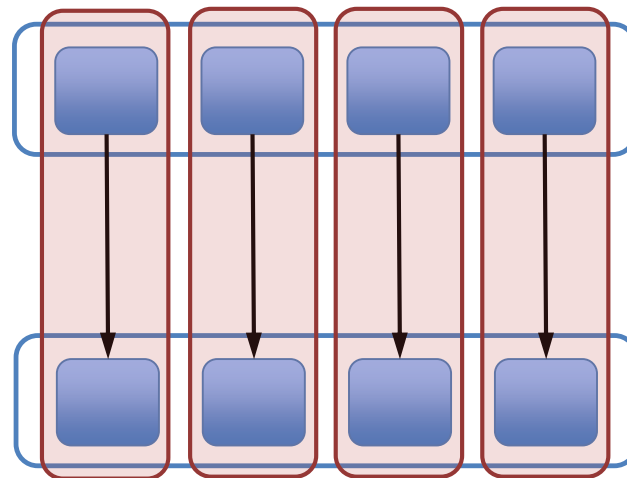
HadoopRDD
path = hdfs://...



errors:

FilteredRDD
func = _.contains(...)
shouldCache = true

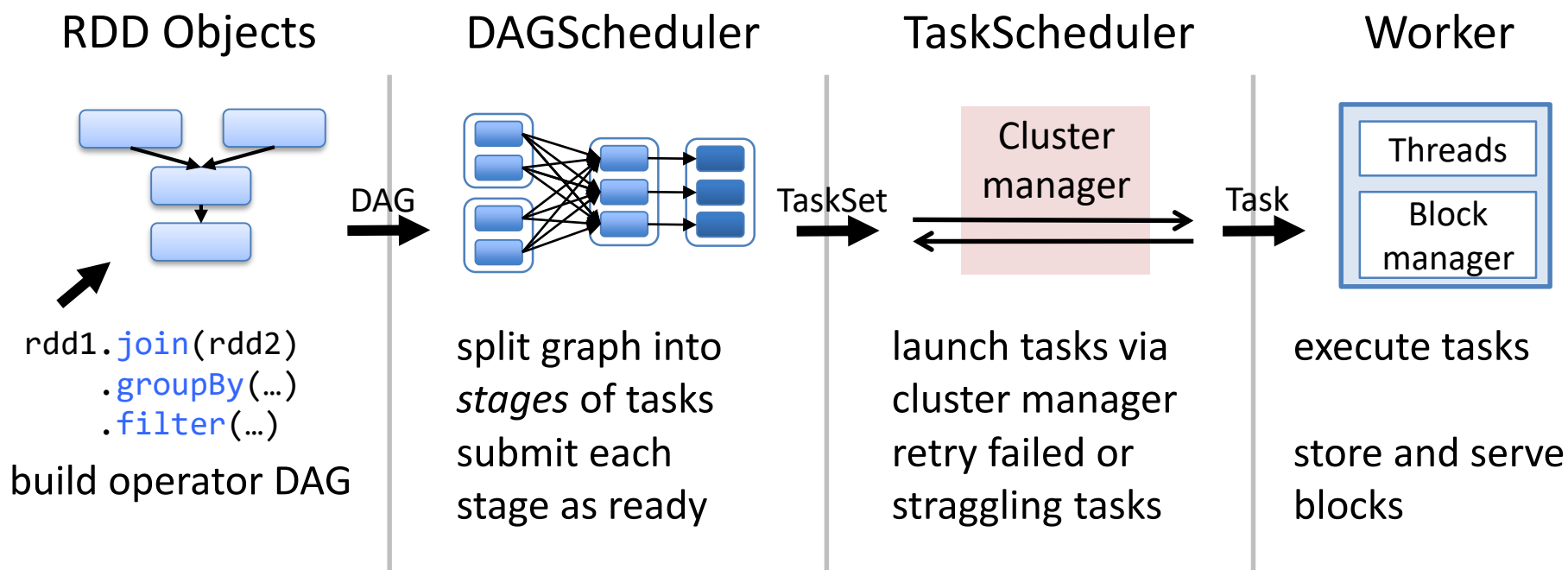
Partition-level view:



Task 1 Task 2 ...

source: <https://cwiki.apache.org/confluence/display/SPARK/Spark+Internals>

Job scheduling



source: <https://cwiki.apache.org/confluence/display/SPARK/Spark+Internals>

Available APIs

- You can write in Java, Scala or Python
- Interactive interpreter: Scala & Python only
- Standalone applications: any
- Performance: Java & Scala are faster thanks to static typing

Hand on - interpreter

- script

<http://cern.ch/kacper/spark.txt>

- run scala spark interpreter

```
$ spark-shell
```

- or python interpreter

```
$ pyspark
```

Hand on – build and submission

- download and unpack source code

```
wget http://cern.ch/kacper/GvaWeather.tar.gz; tar -xzf GvaWeather.tar.gz
```

- build definition in

```
GvaWeather/gvaweather.sbt
```

- source code

```
GvaWeather/src/main/scala/GvaWeather.scala
```

- building

```
cd GvaWeather  
sbt package
```

- job submission

```
spark-submit --master local --class GvaWeather \  
    target/scala-2.10/gva-weather_2.10-1.0.jar
```

Summary

- **Concept not limited to single pass map-reduce**
- **Avoid sorting intermediate results on disk or HDFS**
- **Speedup computations when reusing datasets**

Conclusion

- **RDDs (Resilient Distributed Datasets (RDDs) provide a simple and efficient programming model**
- **Generalized to a broad set of applications**
- **Leverages coarse-grained nature of parallel algorithms for failure recovery**