



Cloud Computing

Spark Architecture and Useful Links

Seyyed Ahmad Javadi

sajavadi@aut.ac.ir

Fall 2023

Course Logistics

➤ HW2 presentation

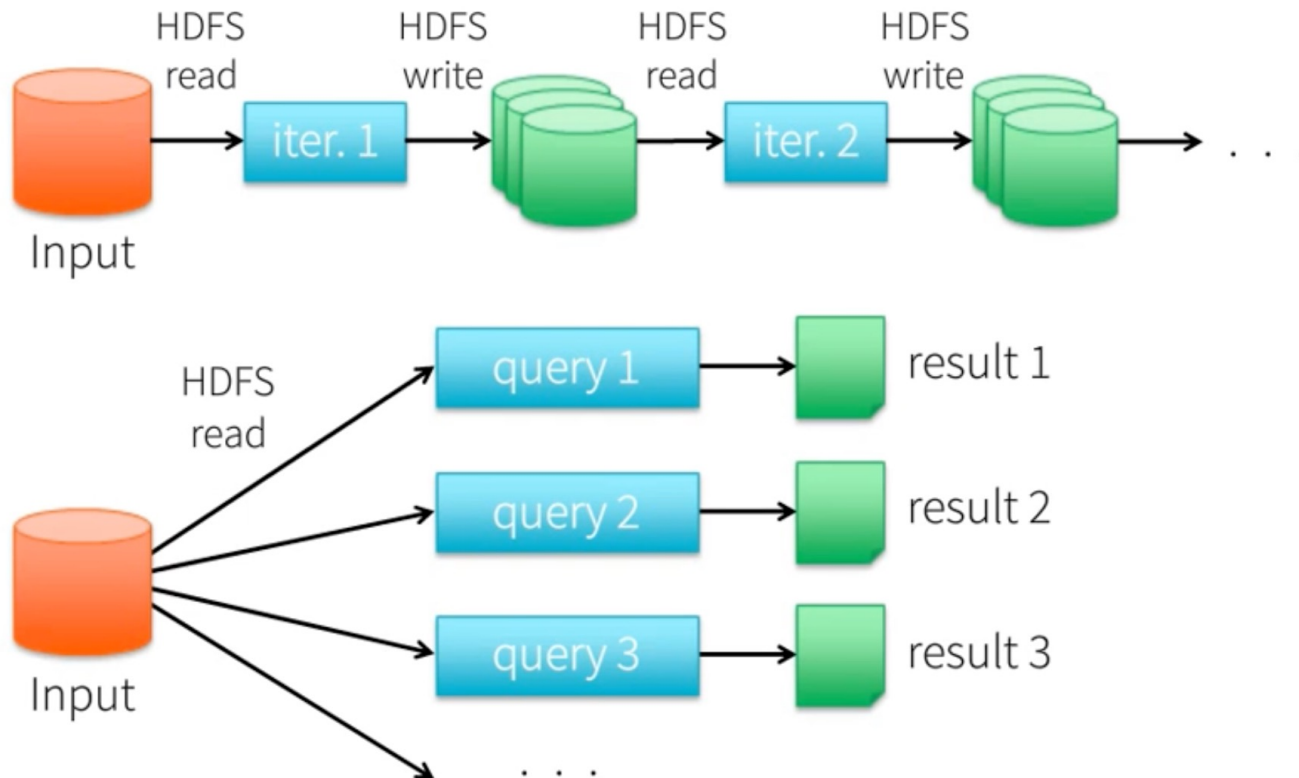
- Last three days of the week

A Quick Review

Few slides from Mr. Zahari's presentation available in the link below:

<https://www.youtube.com/watch?v=d9D-Z3-44F8&t=206s>

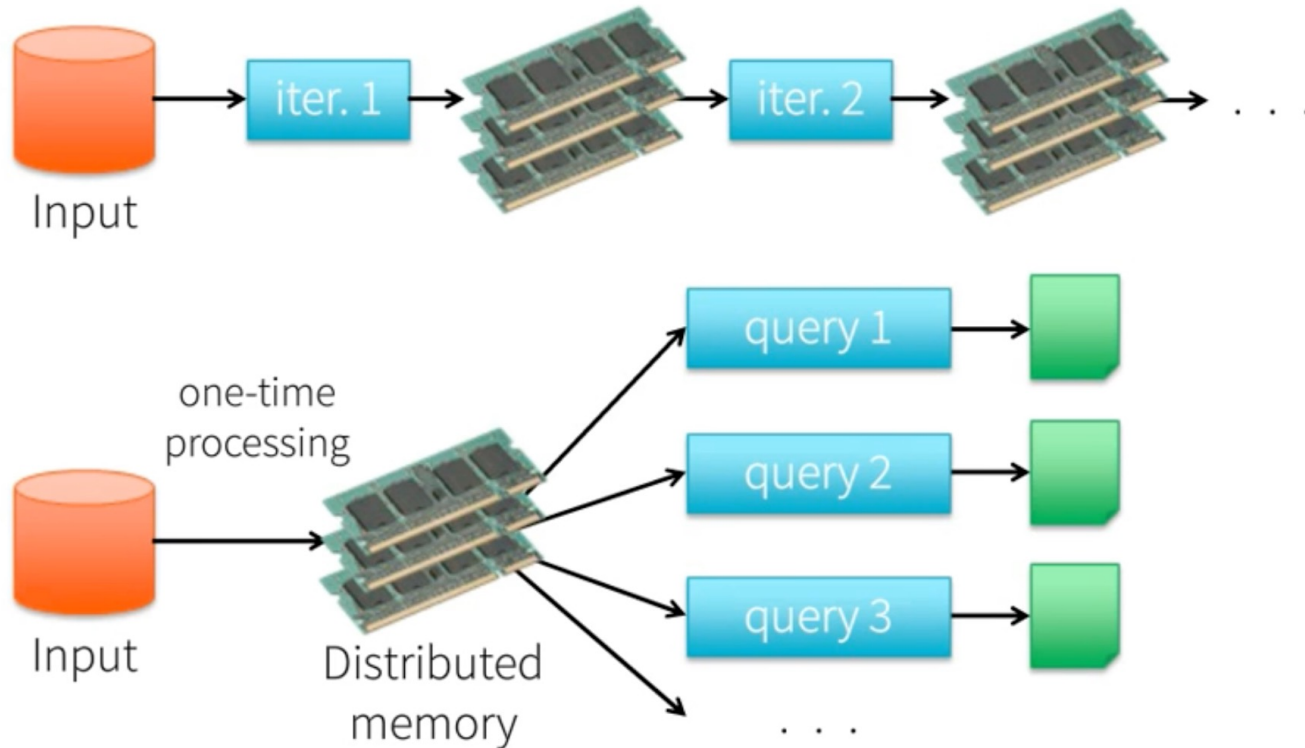
Data Sharing in MapReduce



Slow due to replication and disk I/O

Source: Matei Zaharia's presentation

What We'd Like



10-100x faster than network and disk

Source: Matei Zaharia's presentation

Spark Programming Model

Resilient Distributed Datasets (RDDs)

- Collections of objects stored in RAM or disk across cluster
- Built via parallel transformations (map, filter, ...)
- Automatically rebuilt on failure

Source: Matei Zaharia's presentation

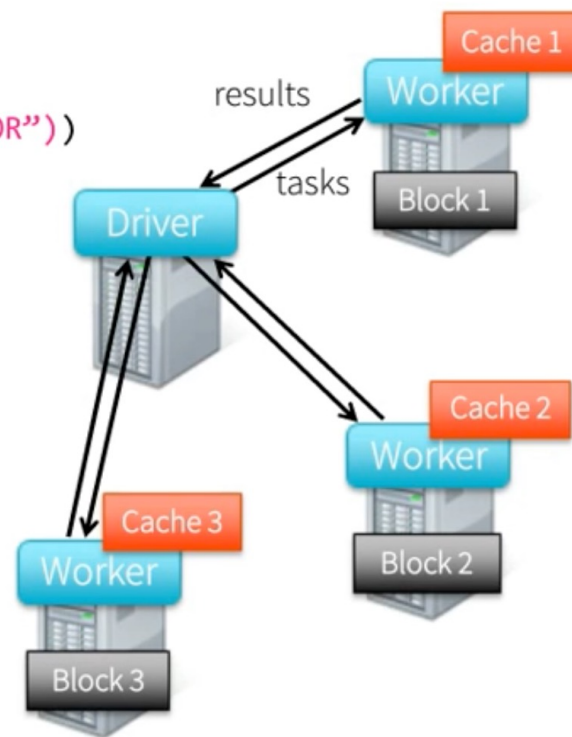
Example: Log Mining

Load error messages from a log into memory, then interactively search for various patterns

```
lines = spark.textFile("hdfs://...")
errors = lines.filter(lambda s: s.startswith("ERROR"))
messages = errors.map(lambda s: s.split('\t')[2])
messages.cache()

messages.filter(lambda s: "MySQL" in s).count()
messages.filter(lambda s: "Redis" in s).count()
. . .
```

Example: full-text search of Wikipedia
in 0.5 sec (vs 20s for on-disk data)



Source: Matei Zaharia's presentation

On-Disk Performance

Time to sort 100TB

2013 Record:
Hadoop

2100 machines



72 minutes



2014 Record:
Spark

207 machines



23 minutes



Source: Matei Zaharia's presentation

Combining Processing Types

```
// Load data using SQL
points = ctx.sql("select latitude, longitude from tweets")

// Train a machine learning model
model = KMeans.train(points, 10)

// Apply it to a stream
sc.twitterStream(...)
  .map(lambda t: (model.predict(t.location), 1))
  .reduceByWindow("5s", lambda a, b: a + b)
```

Source: Matei Zaharia's presentation

Combining Processing Types

Separate systems:



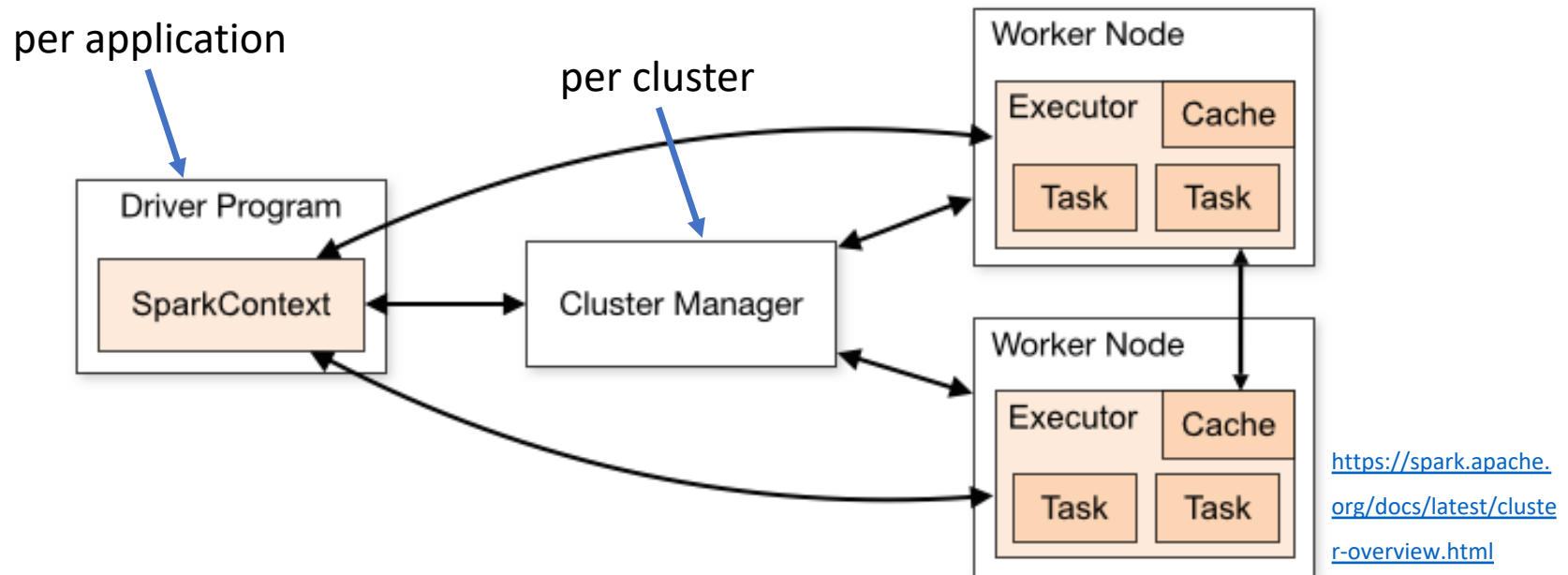
Spark:



Source: Matei Zaharia's presentation

Spark Architecture

Cluster Mode Overview

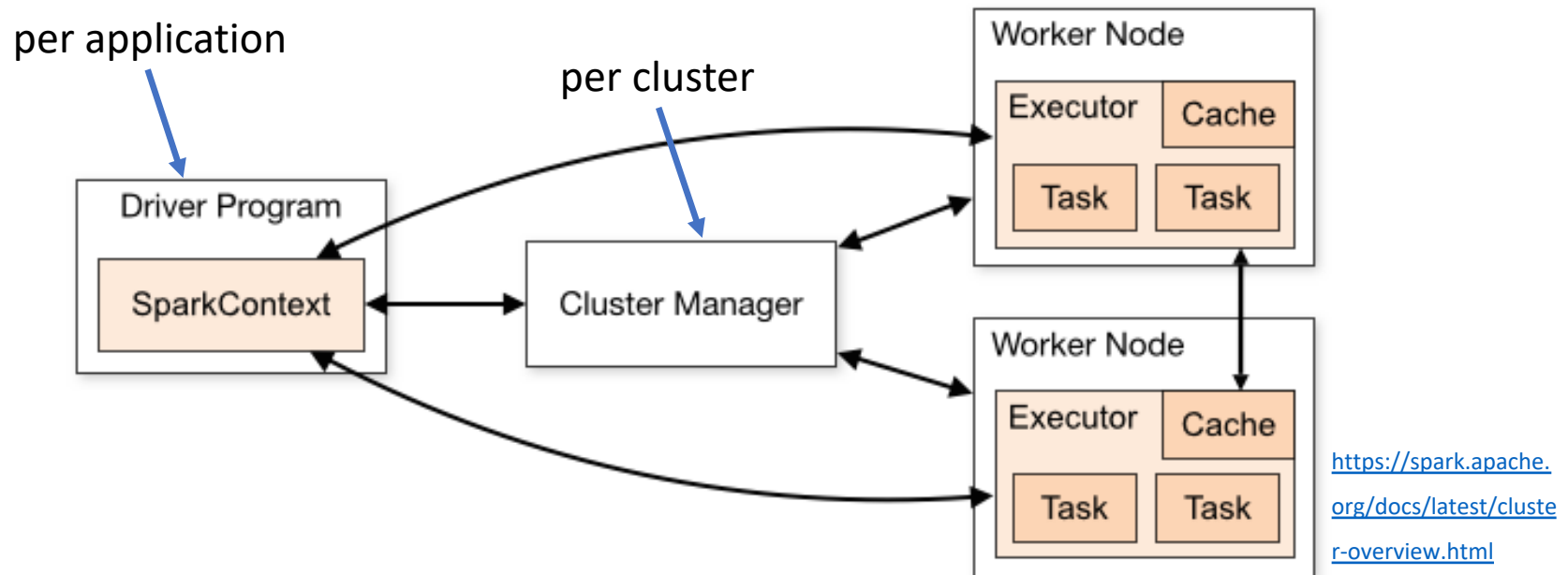


➤ SparkContext can connect to several types of *cluster managers*:

- Spark's own standalone cluster manager,
- Mesos,
- YARN or
- Kubernetes

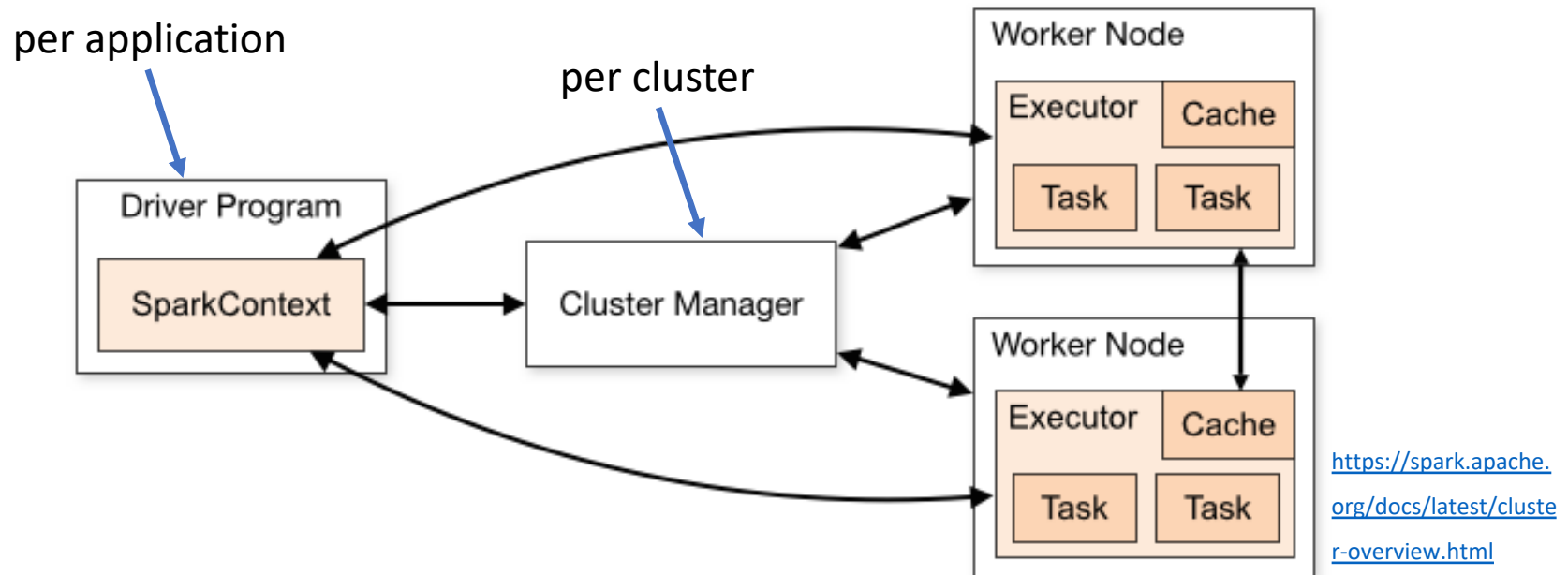
➤ Cluster manager allocates resources across applications.

Cluster Mode Overview (cont.)



- Each application gets its own executor processes.
 - Executor processes run tasks in multiple threads
 - Benefit: isolating applications from each other
 - Challenge: **data cannot** be shared across different Spark applications without writing it to an external storage system.

Cluster Mode Overview (cont.)

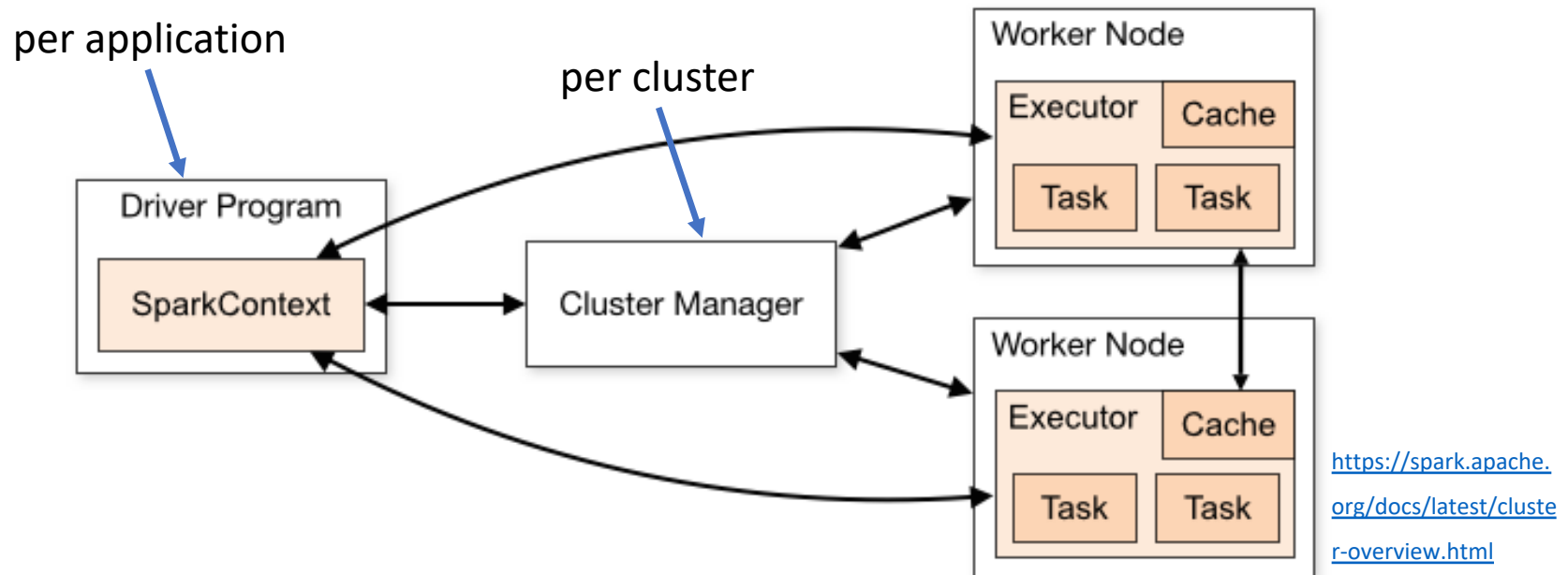


➤ Spark is agnostic to the underlying cluster manager.

- As long as Spark can acquire executor processes & these communicate with each other.



Cluster Mode Overview (cont.)



- The driver program must listen for and accept incoming connections from its executors throughout its lifetime.
- As such, the driver program must be network addressable from the worker nodes.

Cluster Manager Types

- Standalone
 - A simple cluster manager included with Spark making it easy to set up a cluster.
- Apache Mesos
 - A general cluster manager that can also run Hadoop MapReduce and service applications. (Deprecated)
- Hadoop YARN
 - The resource manager in Hadoop 2.
- Kubernetes
 - An open-source system for automating deployment, scaling, and management of containerized applications.