# The Building Blocks of Hadoop - HDFS, MapReduce, and YARN

## INTRODUCING HADOOP

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# Overview

Understand the need for Distributed Computing

Understand the role of Hadoop in a distributed computing setup

Get introduced to core technologies which work on Hadoop

# How Much Data Do These Organizations Deal With?

Facebook

NSA

Google

# Facebook

Current storage = 300 petabytes

Processed per day = 600 terabytes

Users per month = 1 billion

Likes per day = 2.7 billion

Photos uploaded per day = 300 million

# NSA

Current storage = ~5 exabytes

Processed per day = 30 petabytes

NSA touches 1.6% of internet traffic per day

Web searches, websites visited, phone calls, credit/debit card transactions, financial and health information

Google

Current storage = 15 exabytes

Processed per day = 100 petabytes

Number of pages indexed = 60 trillion

Unique search users per month > 1 billion

Searches per second = 2.3 million

# Huge Data Set

Facebook

NSA

Google

# Huge Data Set

Huge Data Set

**Cannot meet big data requirements**

# Big Data System Requirements

## Raw data

Store massive amounts of data

# Big Data System Requirements

**Store**

**Extract useful information**

Store massive amounts of data

Process it in a timely manner

# Big Data System Requirements

**Store**

Store massive amounts of data

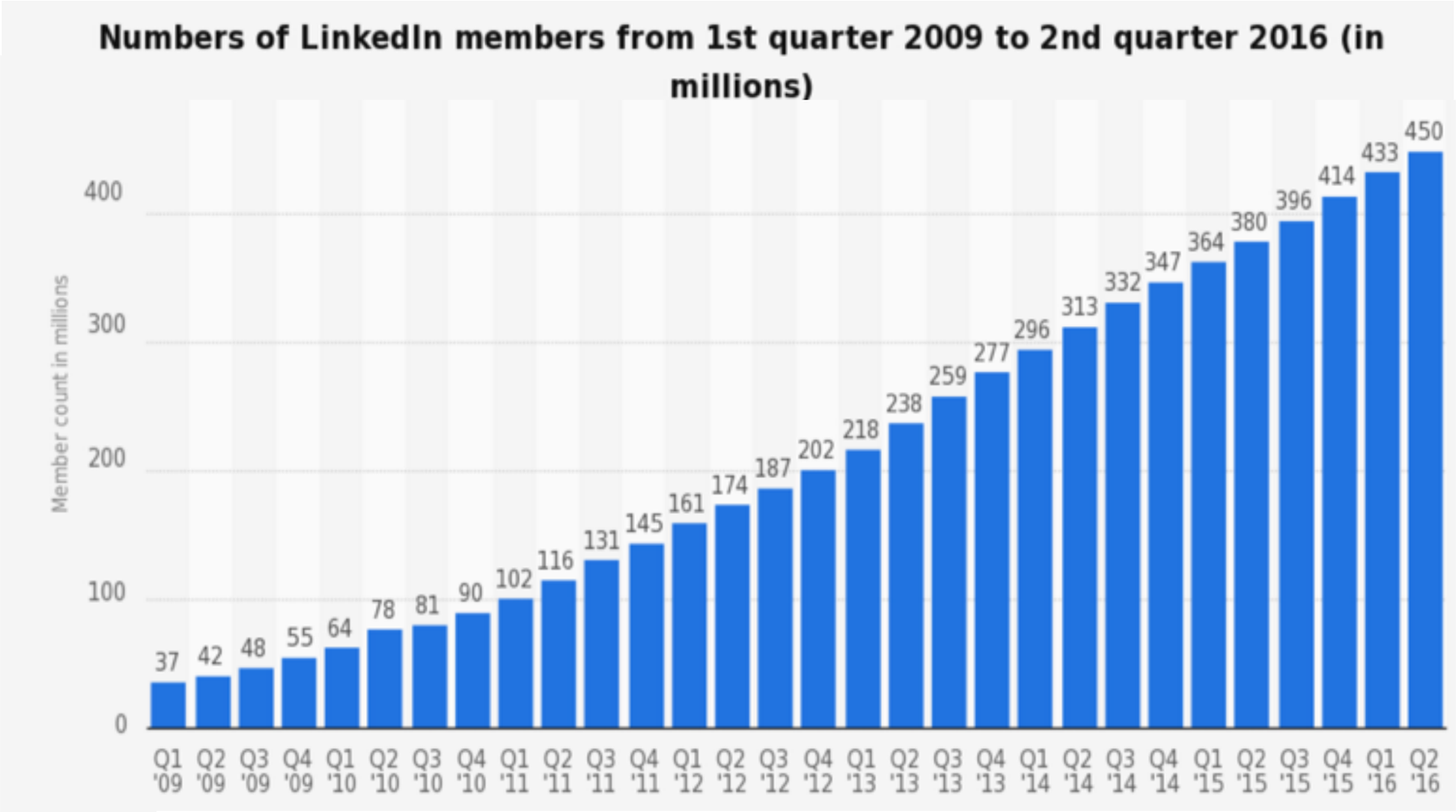
**Process**

Process it in a timely manner

**?**

# Store Process ?

# Growing size of data



# Store Process ?

The infrastructure needs to keep up with the growing size of data

# Big Data System Requirements

**Store**

Store massive amounts of data

**Process**

Process it in a timely manner

**Accommodate changing needs**

Scale easily as data grows

# Big Data System Requirements

**Store**

Store massive amounts of data

**Process**

Process it in a timely manner

**Scale**

Scale easily as data grows

# Big Data System Requirements

**Traditional data technologies don't cut it anymore**

**Store** **Process** **Scale**

**Distributed Computing Frameworks**
like Hadoop were developed for
exactly this

# Two Ways to Build a System

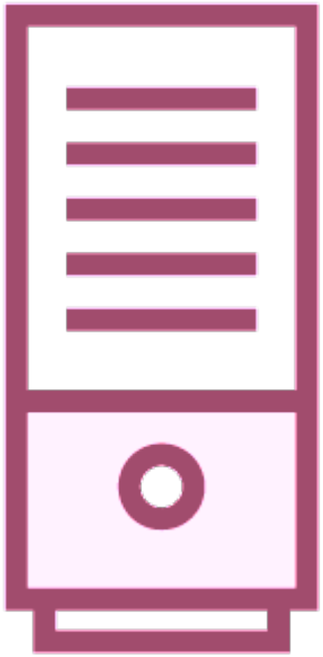
**Monolithic**

**Distributed**

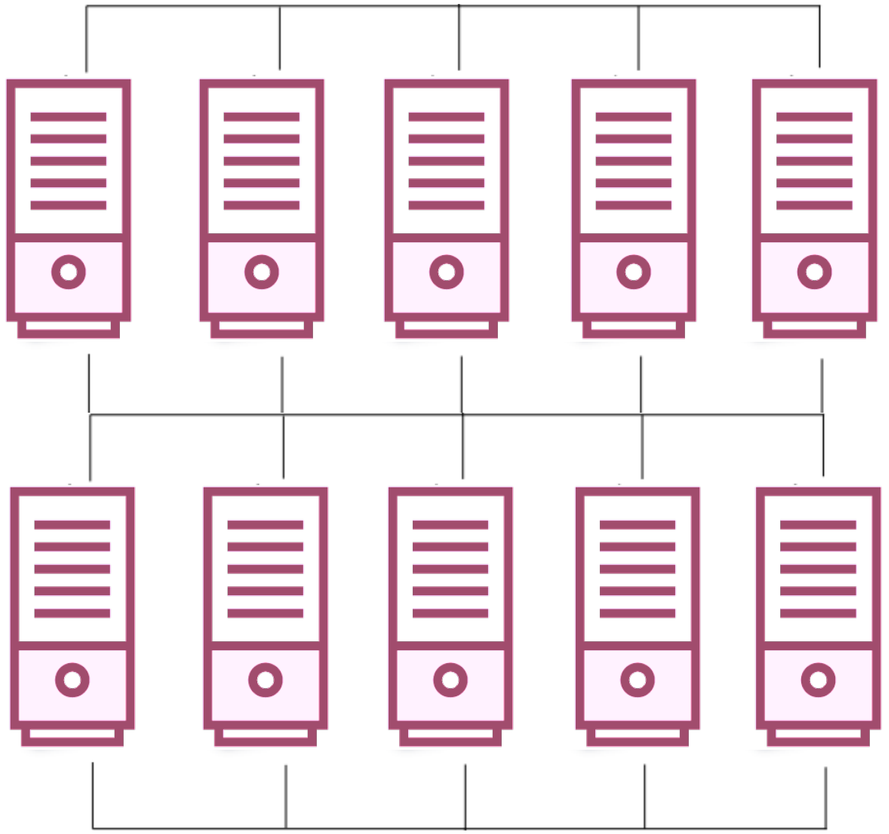
# Two Ways to Build a Team

A star who dribbles and shoots

A team of good players who know how to pass



A supercomputer



A cluster of decent machines that know how to parallelize

# Two Ways to Build a System

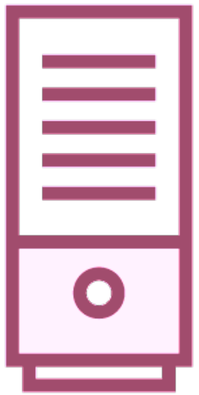
**Monolithic**

**Distributed**

# Monolithic

One star player

Monolithic



A single powerful server

2x Expense

< 2x Performance

# Two Ways to Build a System

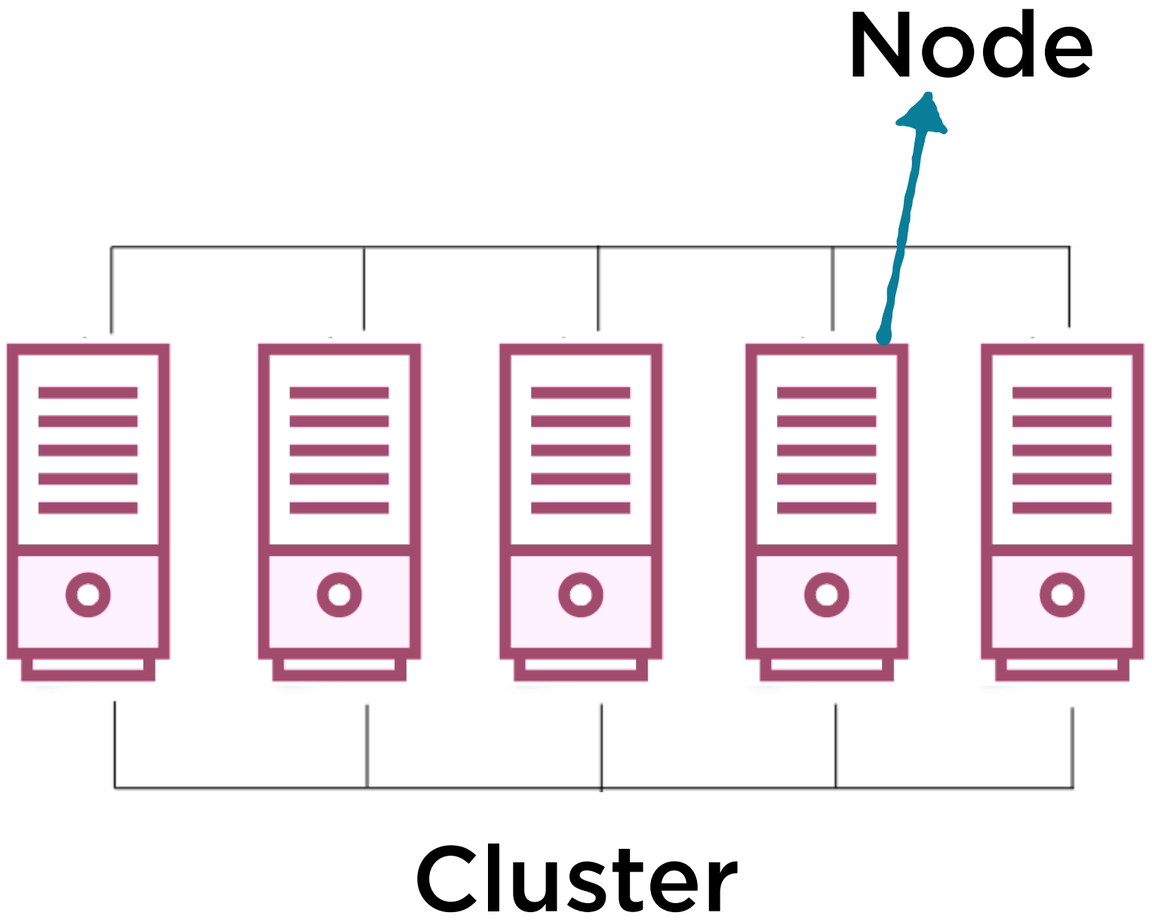
**Monolithic**

**Distributed**

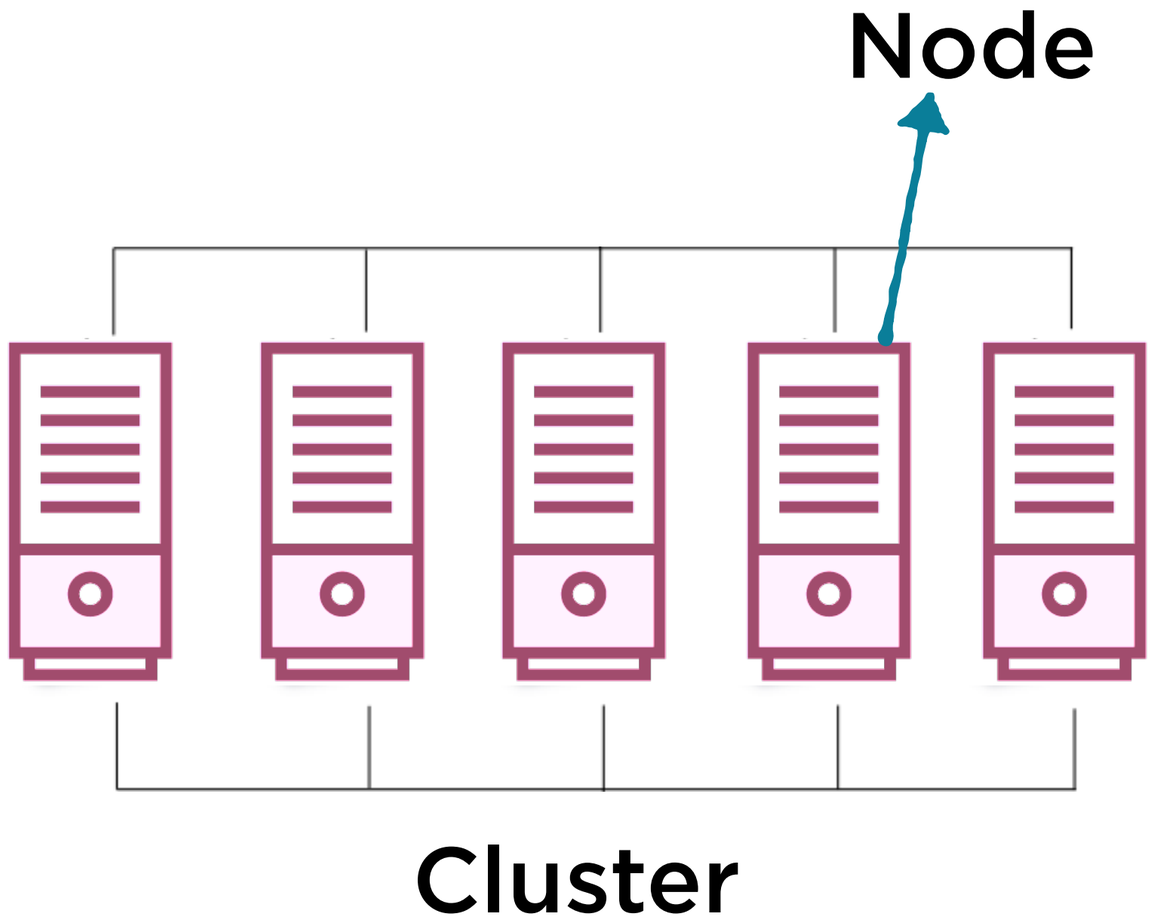
# Distributed

A team of good players who know how to pass

# Distributed



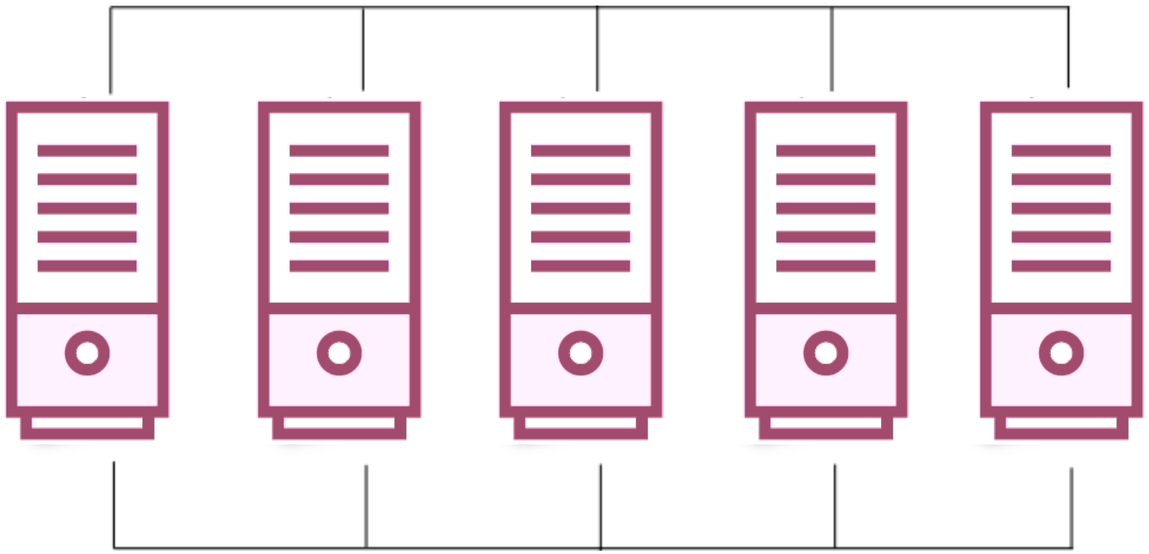
# Distributed System




Many small and cheap computers come together...

...to act as a single entity

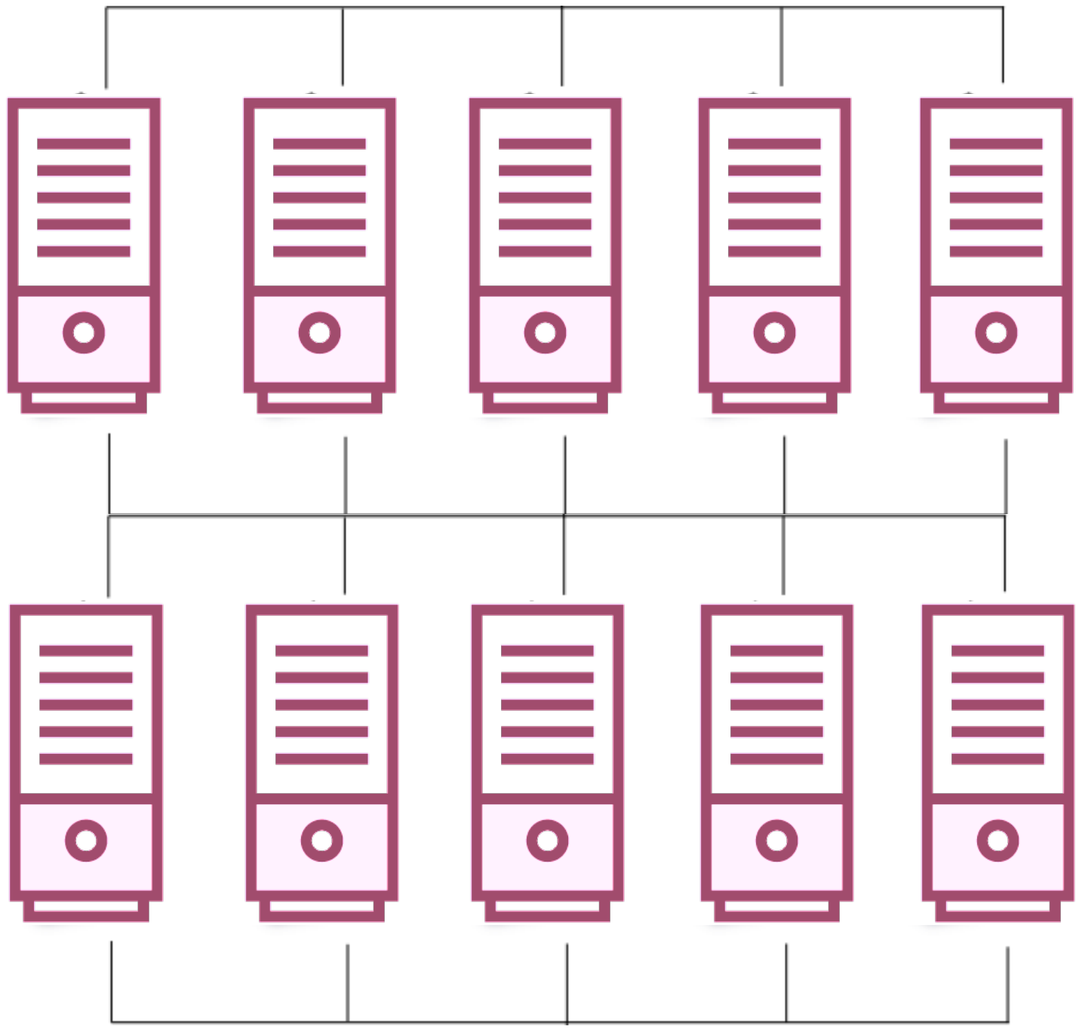
# Distributed System



Cluster

**Such a system can scale linearly**

# Distributed System



2x Nodes

2x Storage

~ 2x Speed

# Server Farms

**Companies like Facebook, Google, Amazon are building vast server farms**

# Server Farms

**These farms have 100s of 1000s of servers working in tandem to process complex data**

# Server Farms

All of these servers need to be co-ordinated by a single piece of software

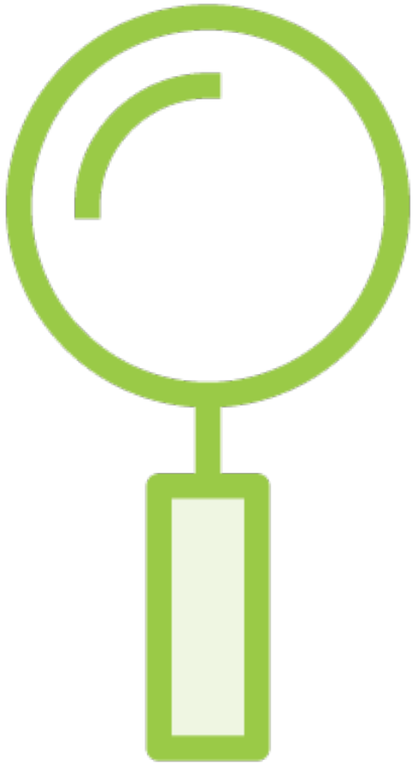
# Single Co-ordinating Software

- **Partition data**
- **Co-ordinate computing tasks**
- **Handle fault tolerance and recovery**
- **Allocate capacity to processes**

**Store** **Process** **Scale**

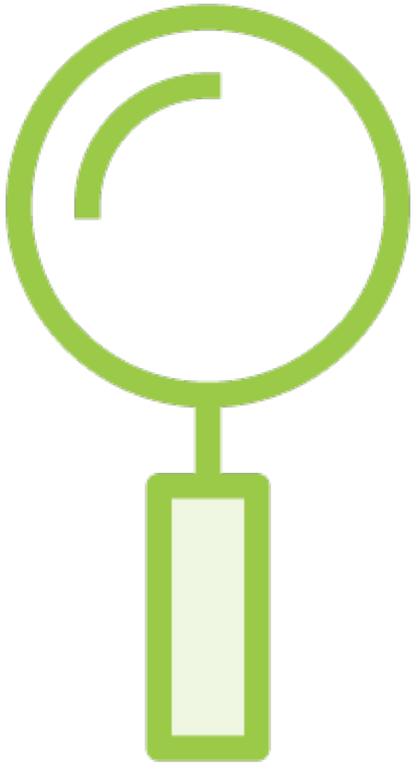
**Distributed Computing** makes for a lot of complexity

# Single Co-ordinating Software



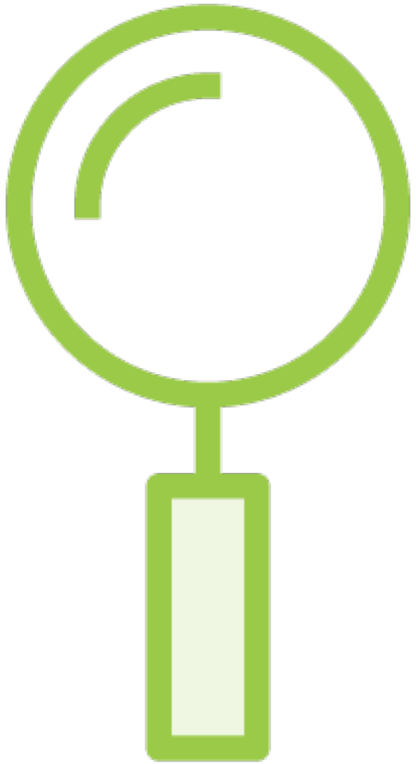
**Back in the early 2000s Google realized that web search requires something completely new**

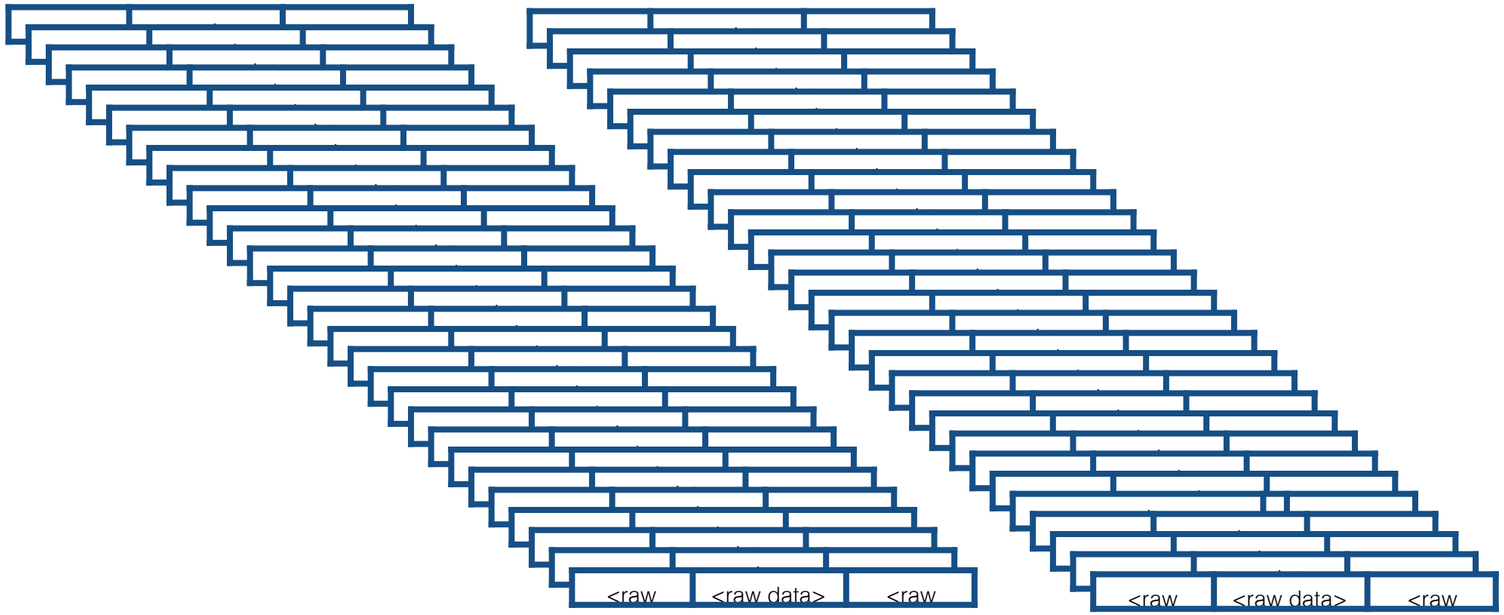
# Single Co-ordinating Software



**Google developed proprietary software to run on these distributed systems**

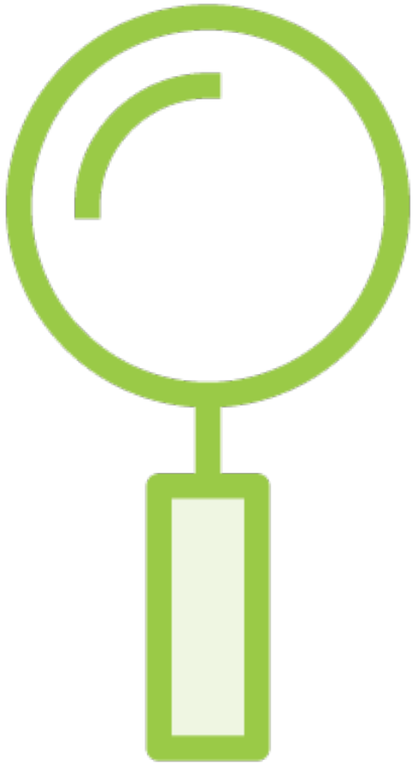
Single Co-ordinating Software

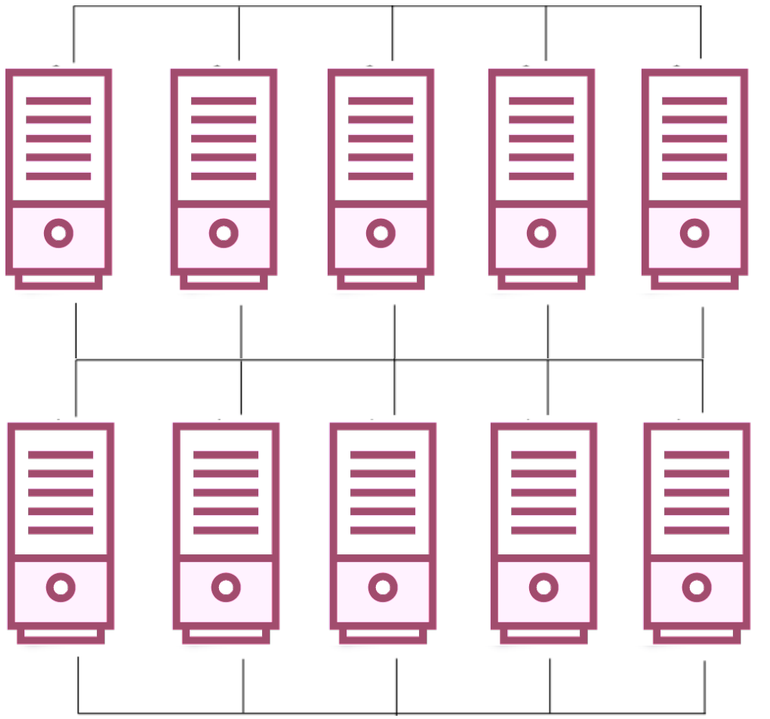





**First: store millions of records on multiple machines**

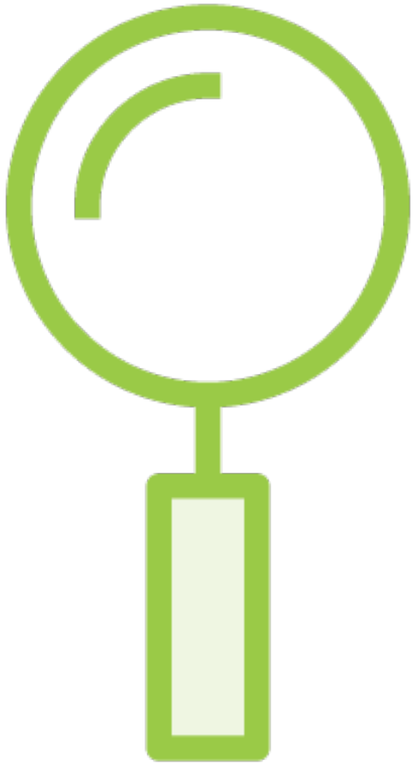
Single Co-ordinating Software





**Second: run processes on all these machines to crunch data**

# Single Co-ordinating Software



Google File System

To solve distributed storage

MapReduce

To solve distributed computing

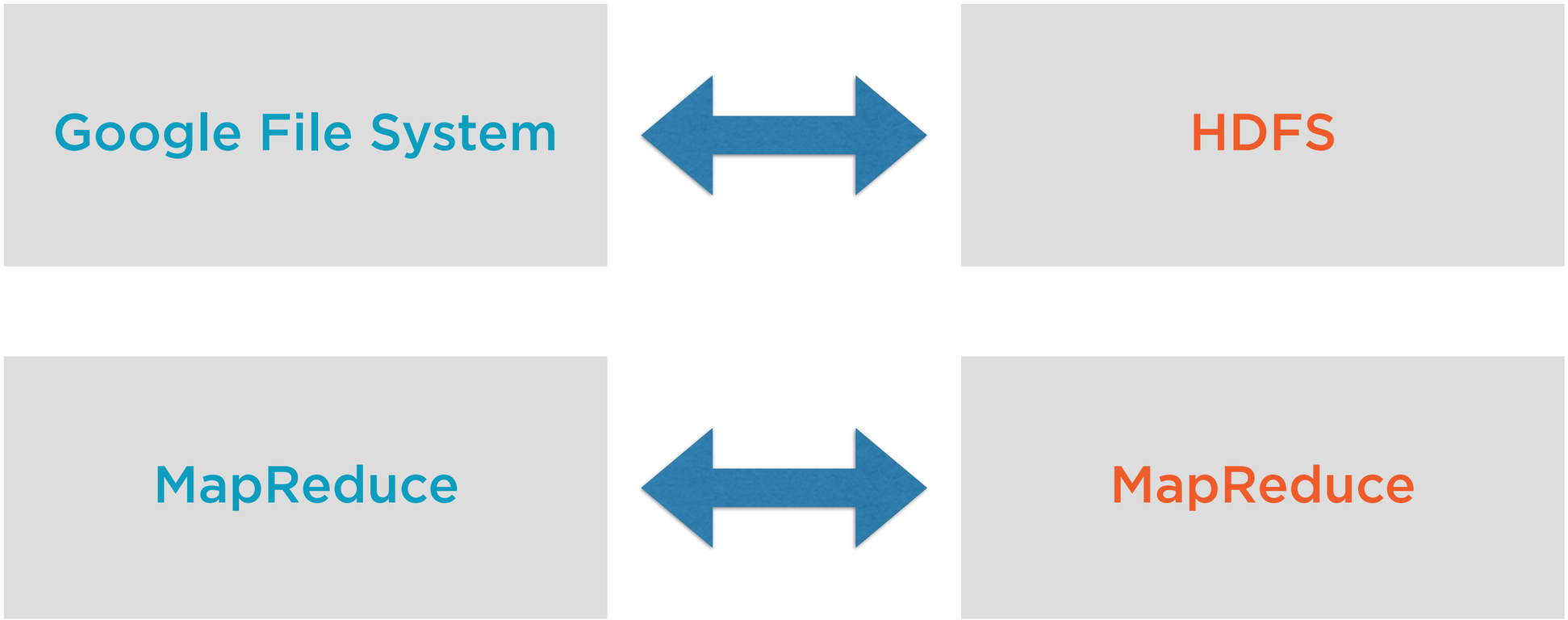
# Single Co-ordinating Software

Google File System

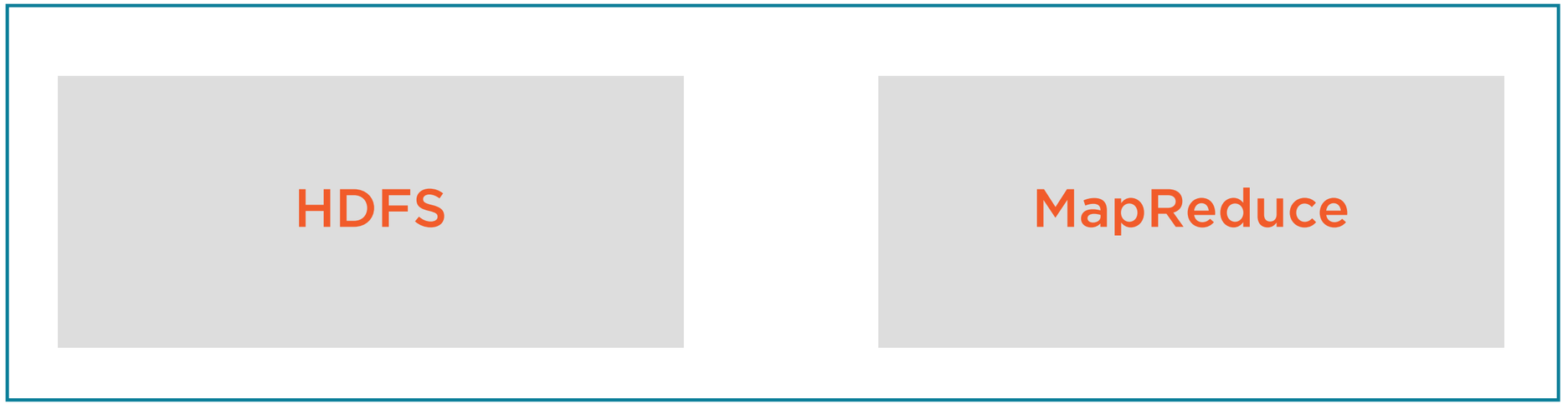
MapReduce

**Apache developed open source versions of these technologies**

# Single Co-ordinating Software



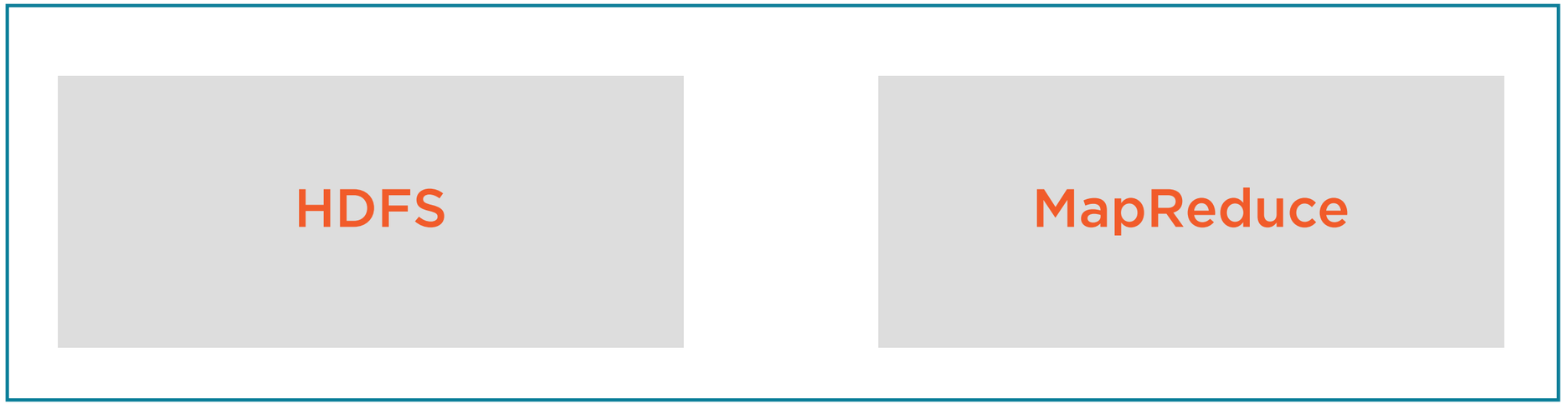
# Hadoop




**A file system to manage the storage of data**

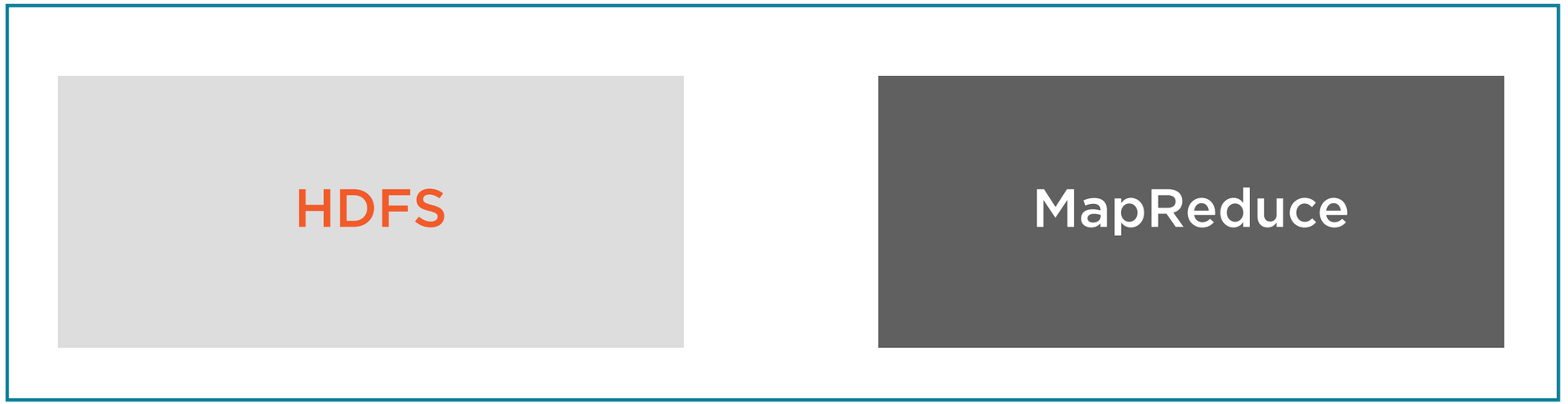
**A framework to process data across multiple servers**

Hadoop




# In 2013, Apache released Hadoop 2.0

# Hadoop




**MapReduce was broken into two separate parts**

# Hadoop

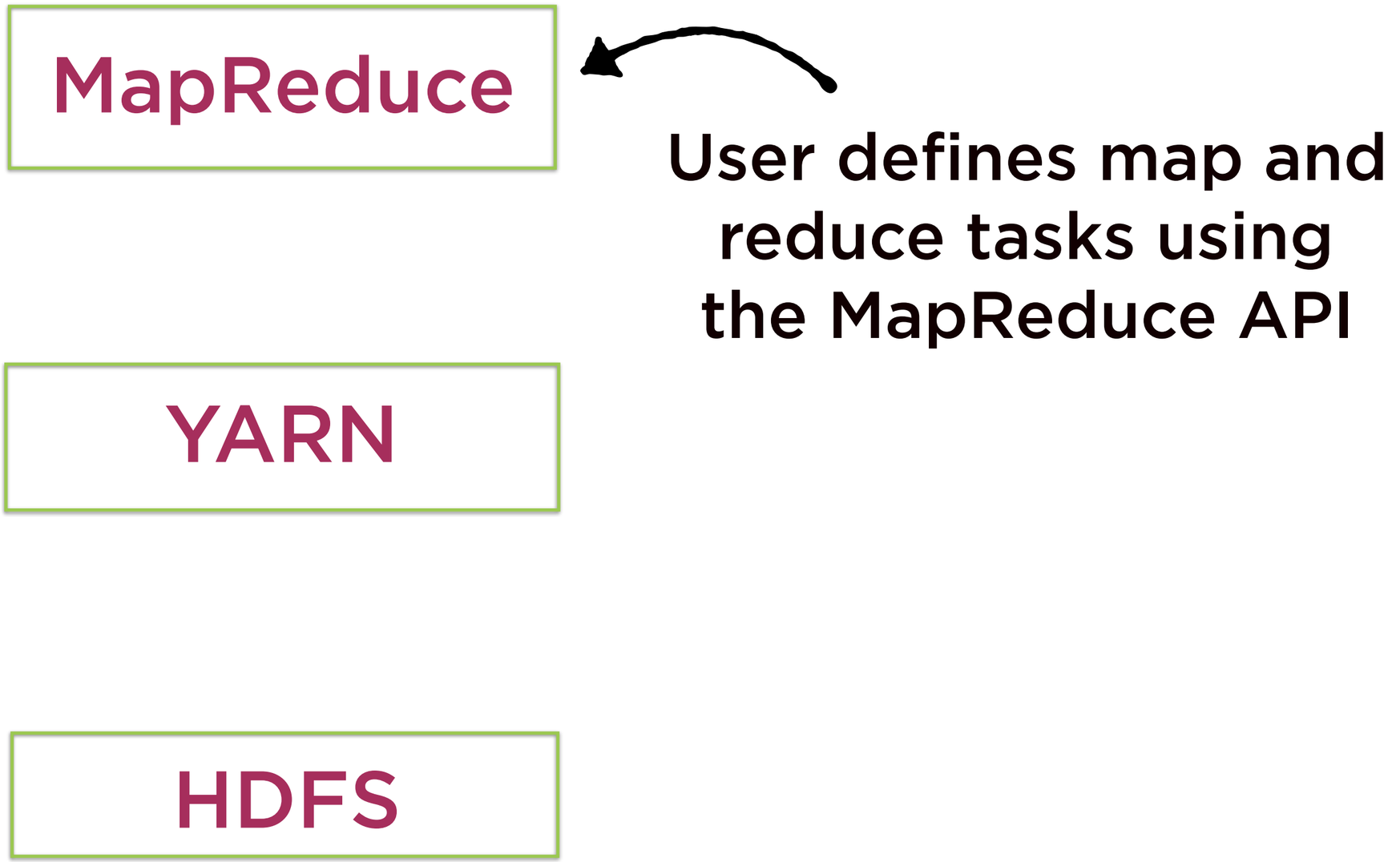
A framework to define a data processing task

A framework to run the data processing task

# Hadoop

**Each of these components have corresponding configuration files**

# Co-ordination Between Hadoop Blocks



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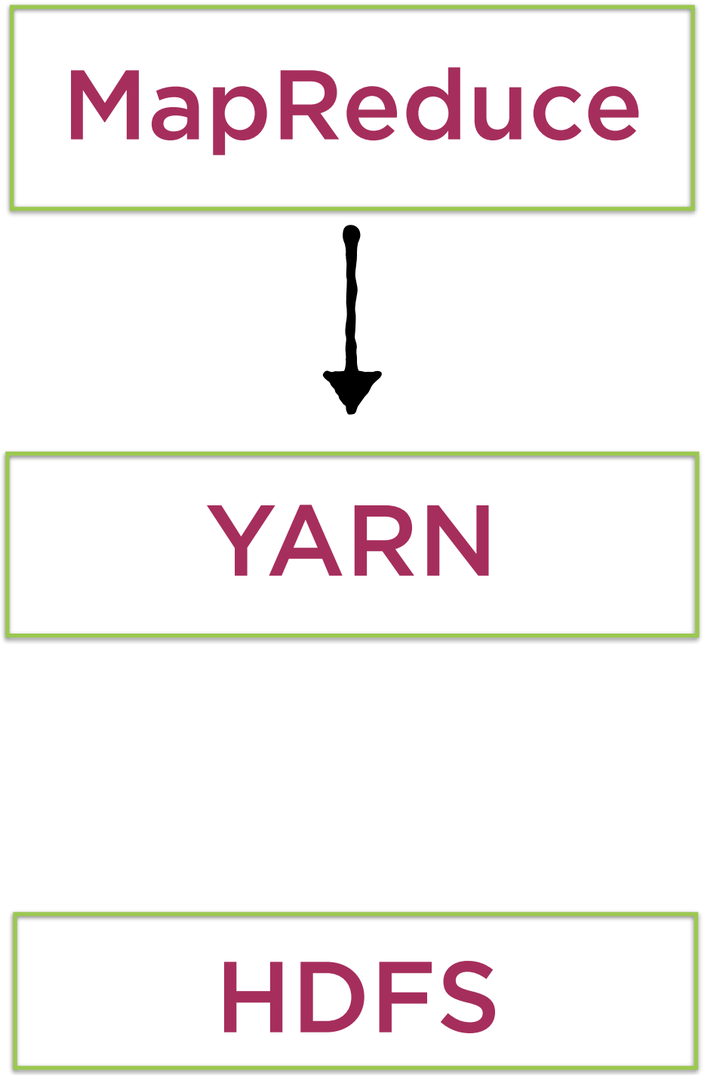
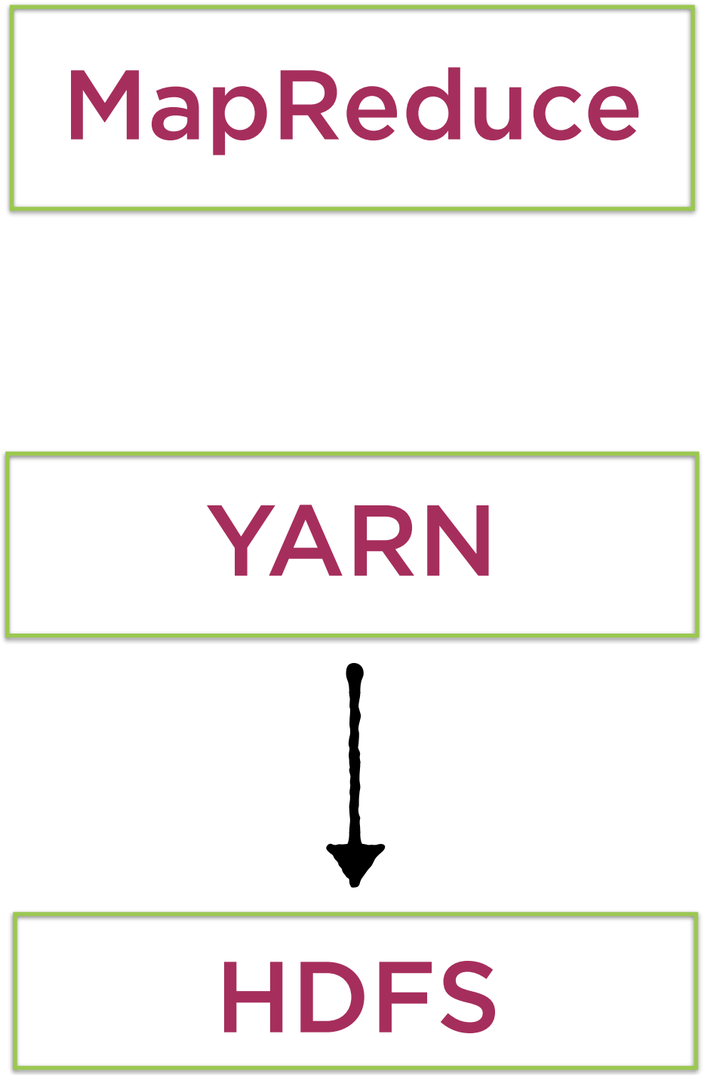



**A job is triggered on the cluster**

# Co-ordination Between Hadoop Blocks

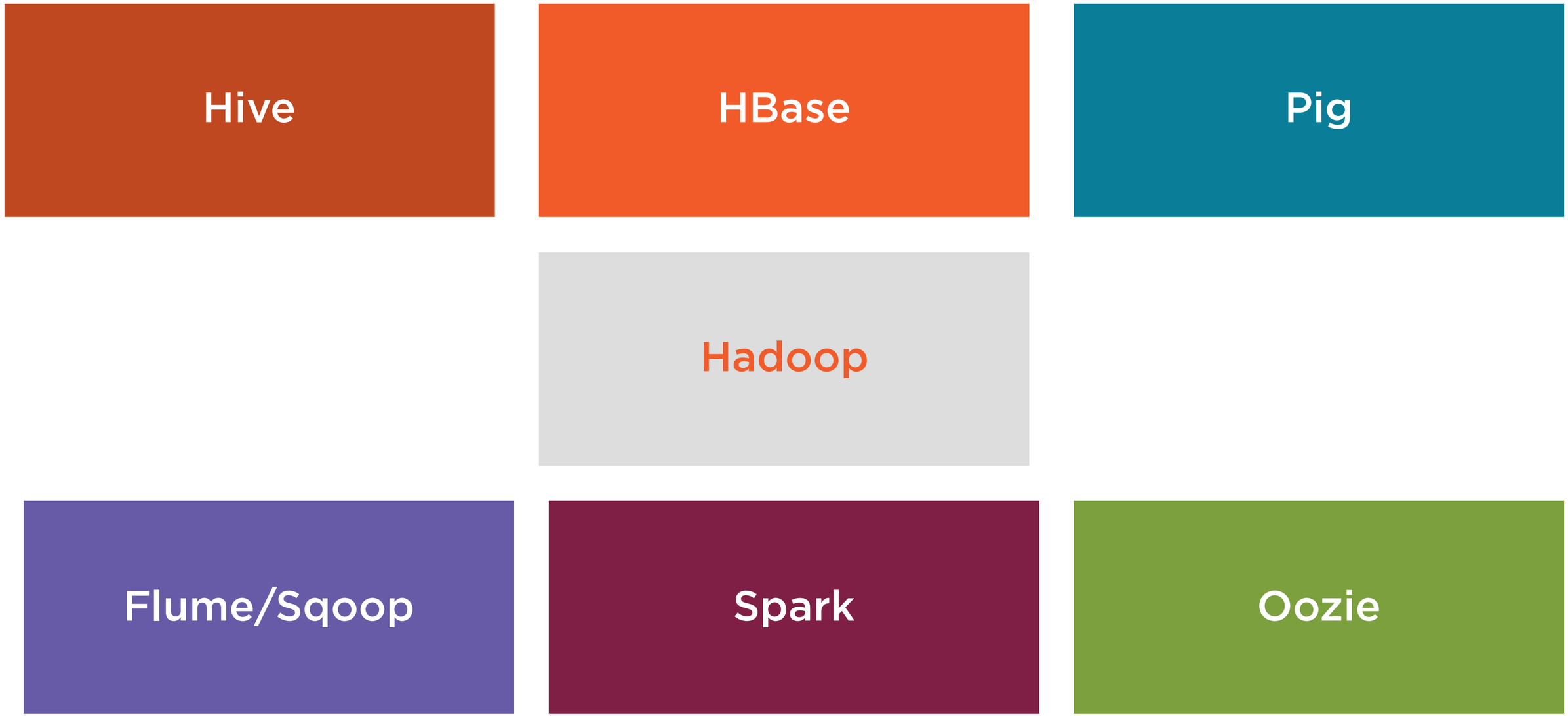



**YARN figures out where and how to run the job, and stores the result in HDFS**

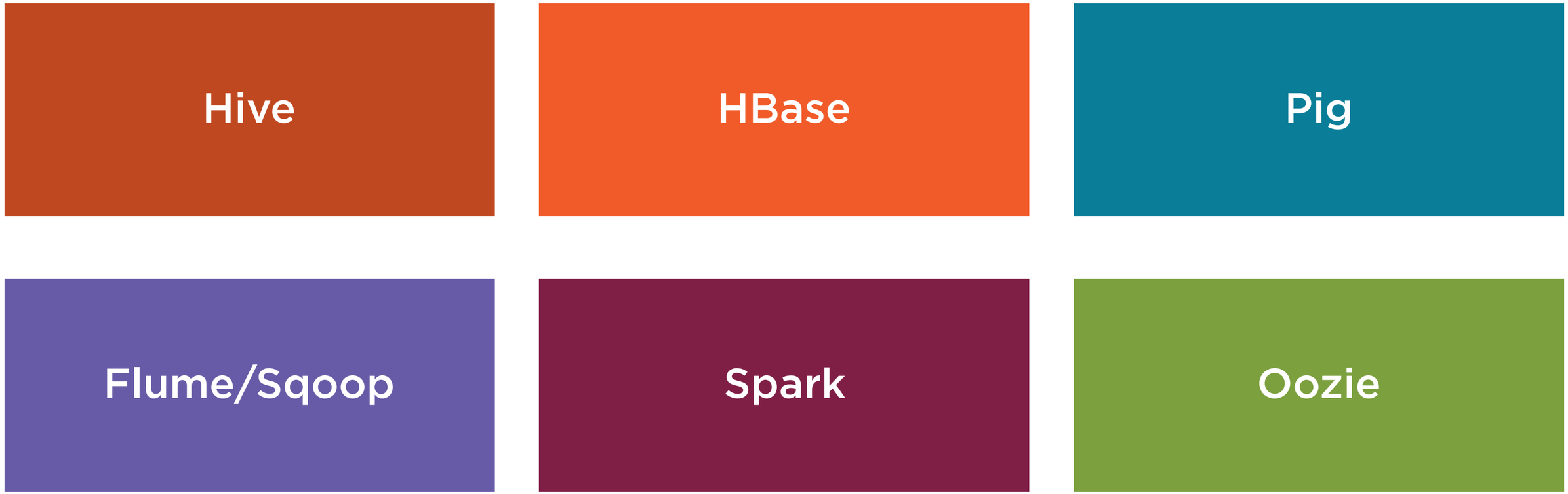
# Hadoop Ecosystem

**An ecosystem of tools have sprung up around this core piece of software**

# Hadoop Ecosystem



# Hadoop Ecosystem



Hive

Provides an SQL interface to Hadoop

The bridge to Hadoop for folks who don’t have exposure to OOP in Java

# HBase

A database management system on top of Hadoop

Integrates with your application just like a traditional database

Pig

A data manipulation language

Transforms unstructured data into a structured format

Query this structured data using interfaces like Hive

# Spark

A distributed computing engine used along with Hadoop

Interactive shell to quickly process datasets

Has a bunch of built in libraries for machine learning, stream processing, graph processing etc.

Oozie

A tool to schedule workflows on all the Hadoop ecosystem technologies

Flume/Sqoop

Tools to transfer data between other systems and Hadoop

# Summary

Understood the need for Distributed Computing

Understood the role of Hadoop in a distributed computing setup

Overview of basic technologies which exist in the Hadoop eco-system