Power of data. Simplicity of design. Speed of innovation.

Hands on Introduction to Apache Spark for Data Engineers, Data Scientists, and Developers at Metlife

MetLife

Agenda

9 am – 10 am	**Kickoff, Apache Spark Overview**
10:00am – 11:00am	Lab 1, Hello Spark - Hand on exercise
11:00 am – 12:00pm	Apache Spark SQL Overview
12:00 pm – 1pm	Lunch
1pm – 2pm	Lab 2, Spark SQL - Hands on exercises
2pm – 3pm	Overview of Data Science & Machine Learning w/ Apache Spark
3pm – 4pm	Lab 3, Machine Learning w/ Spark – Hands on exercises
4pm – 4:30pm	Wrap up – Feedback from attendees

Introductions: Instructor

Joseph Kambourakis
Open Source Analytics Technical Evangelist
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@mouthorjoe

Ground Rules

- **Interrupt me!**
- **The slides will be available**

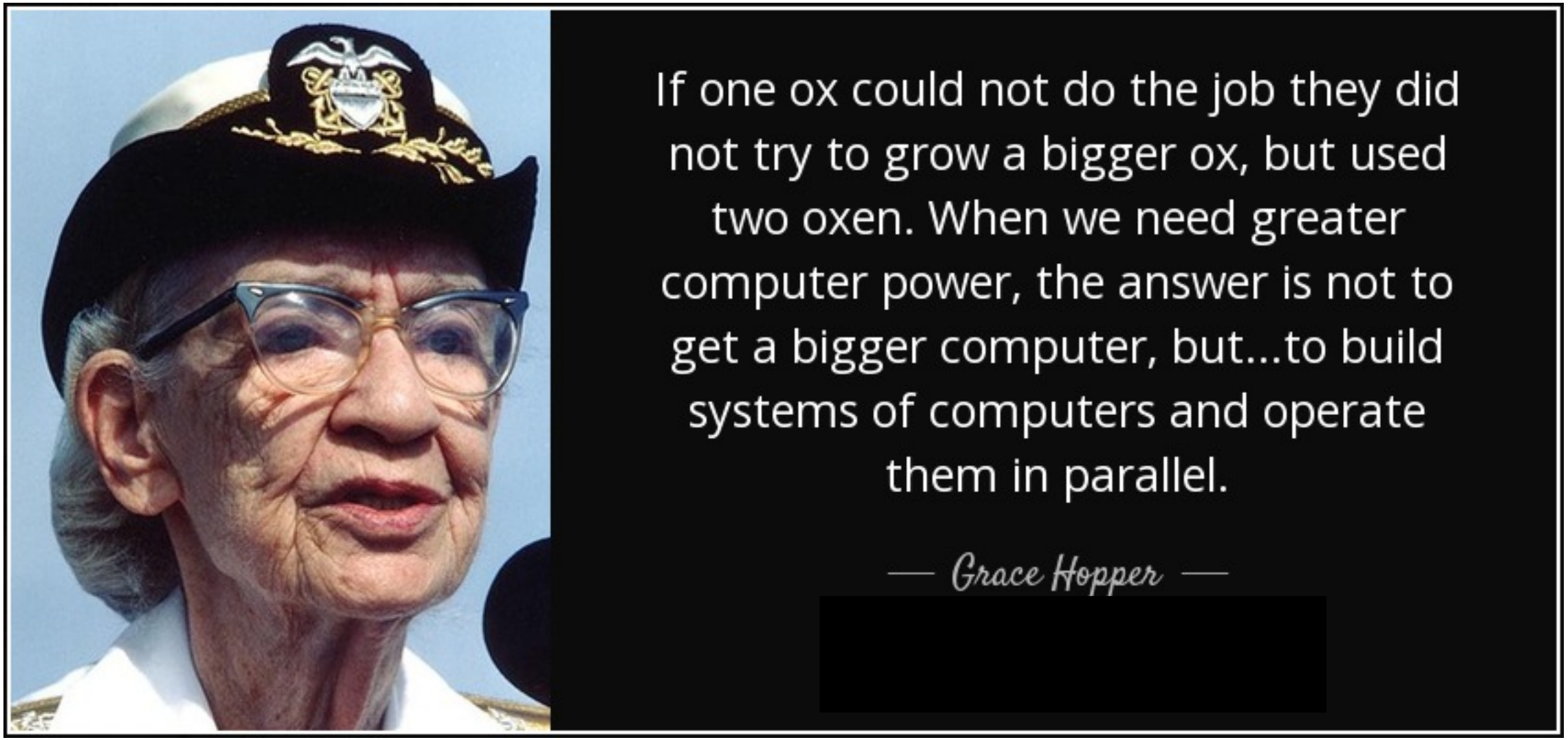
Objectives

- Understand how Spark works
- Write Spark programs
- List different ways IBM uses Spark
- Discuss how to apply to Spark to business problems
- Build relationship between IBM and MetLife

Introductions: Attendees

- **What is your role?**
- **How familiar are you with Spark?**
  - Python?
  - Scala?
- **How familiar are you with Hadoop?**

Grace Hopper



What is Spark?

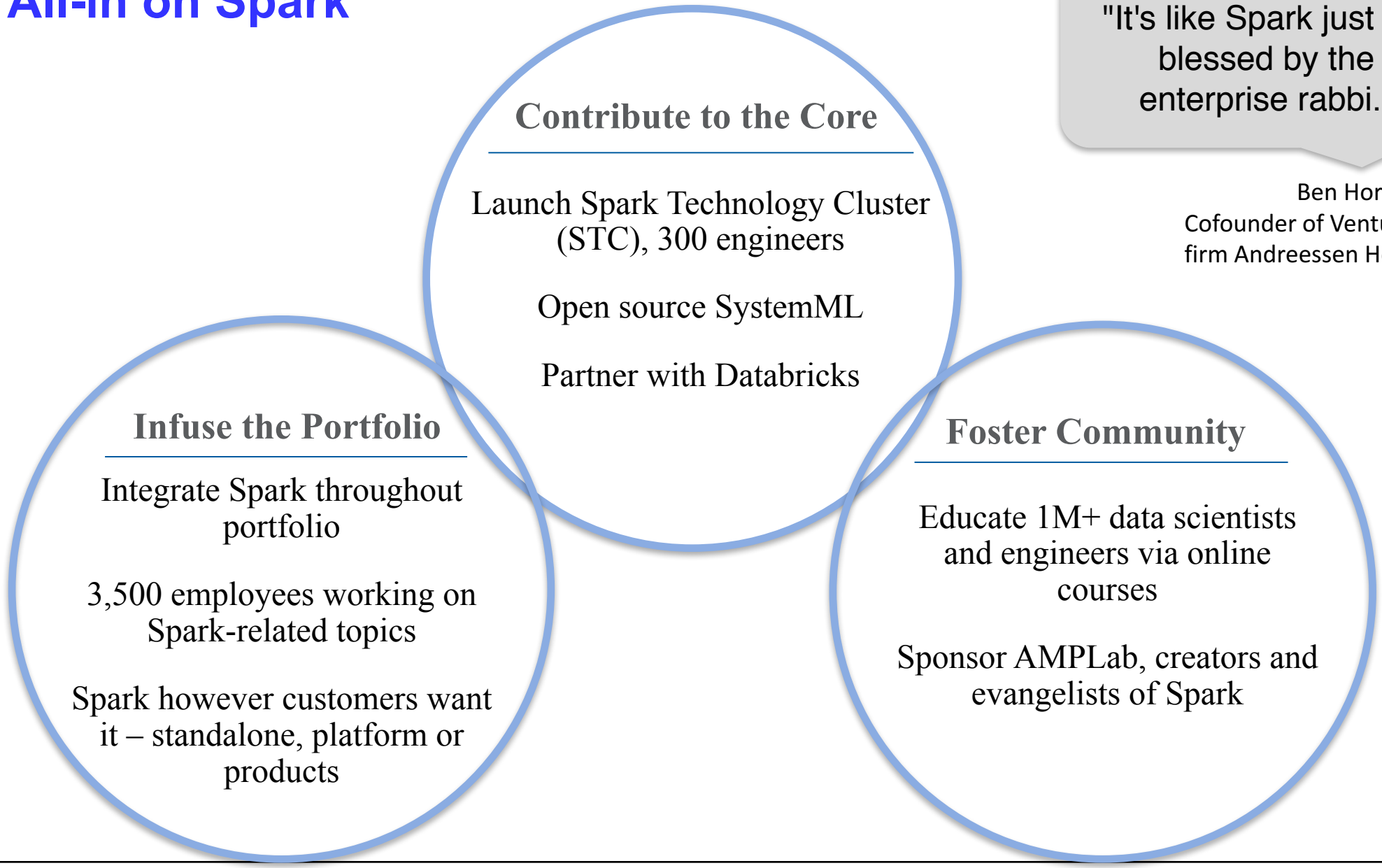
Spark is an **open** source
in-memory
application framework for
distributed data processing and
iterative analysis
on **massive** data volumes

“Analytic Operating System”

IBM is All-in on Spark

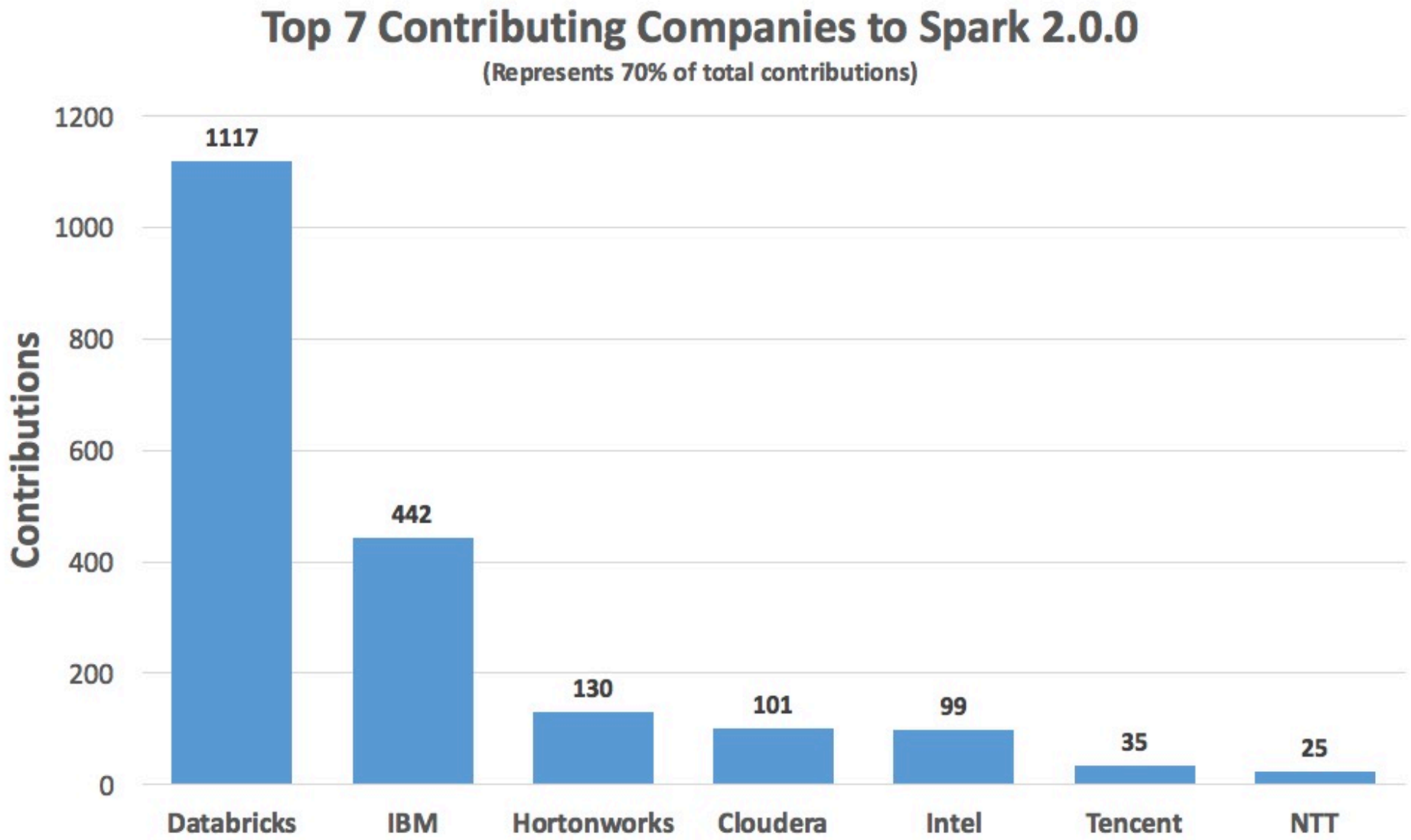
"It's like Spark just got blessed by the enterprise rabbi."

Ben Horowitz,
Cofounder of Venture Capital firm Andreessen Horowitz



Contribute to the Core: Spark Technology Center

Contribute to the Core: Actual Code!

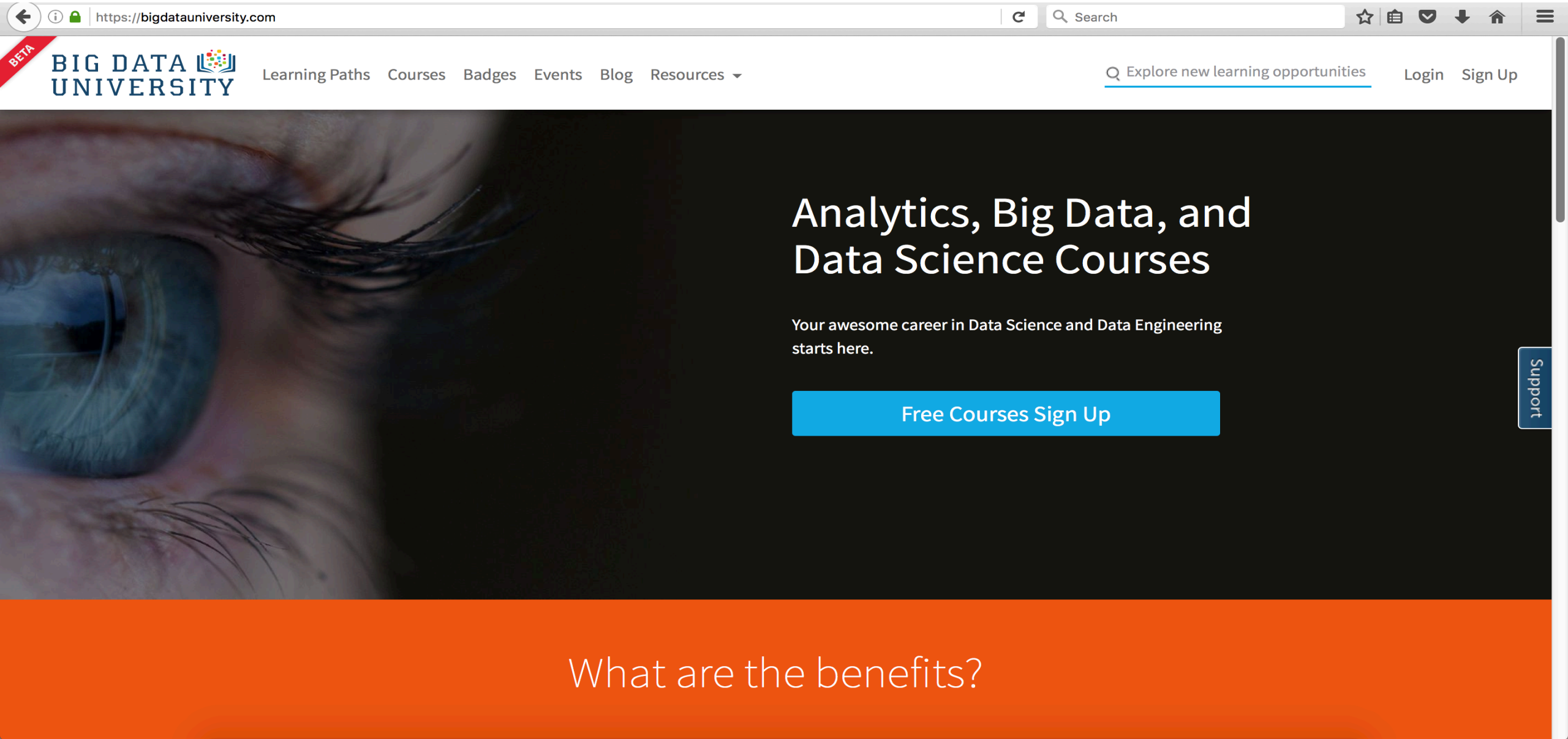


Infuse the Portfolio

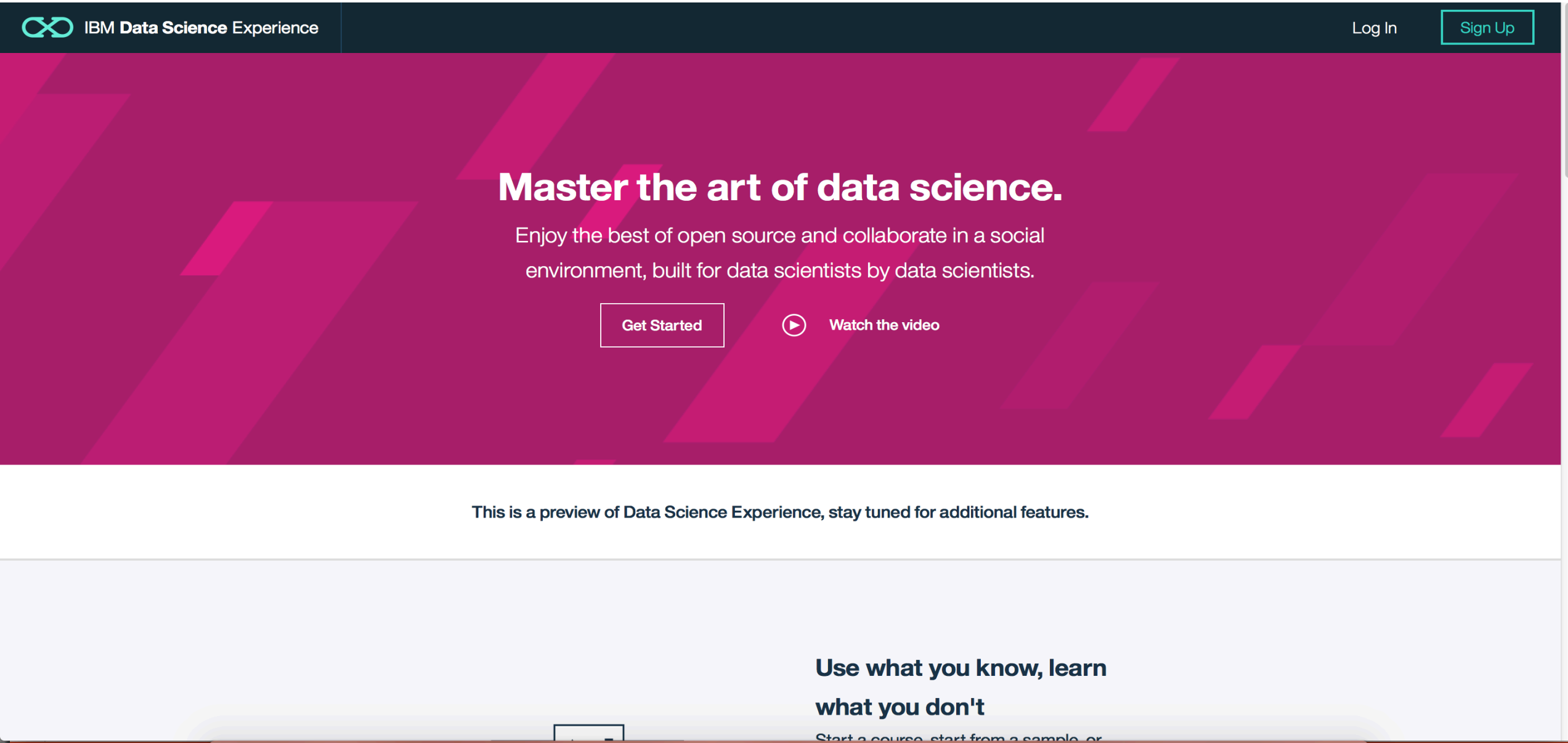
IBM Bluemix

IBM Watson Health

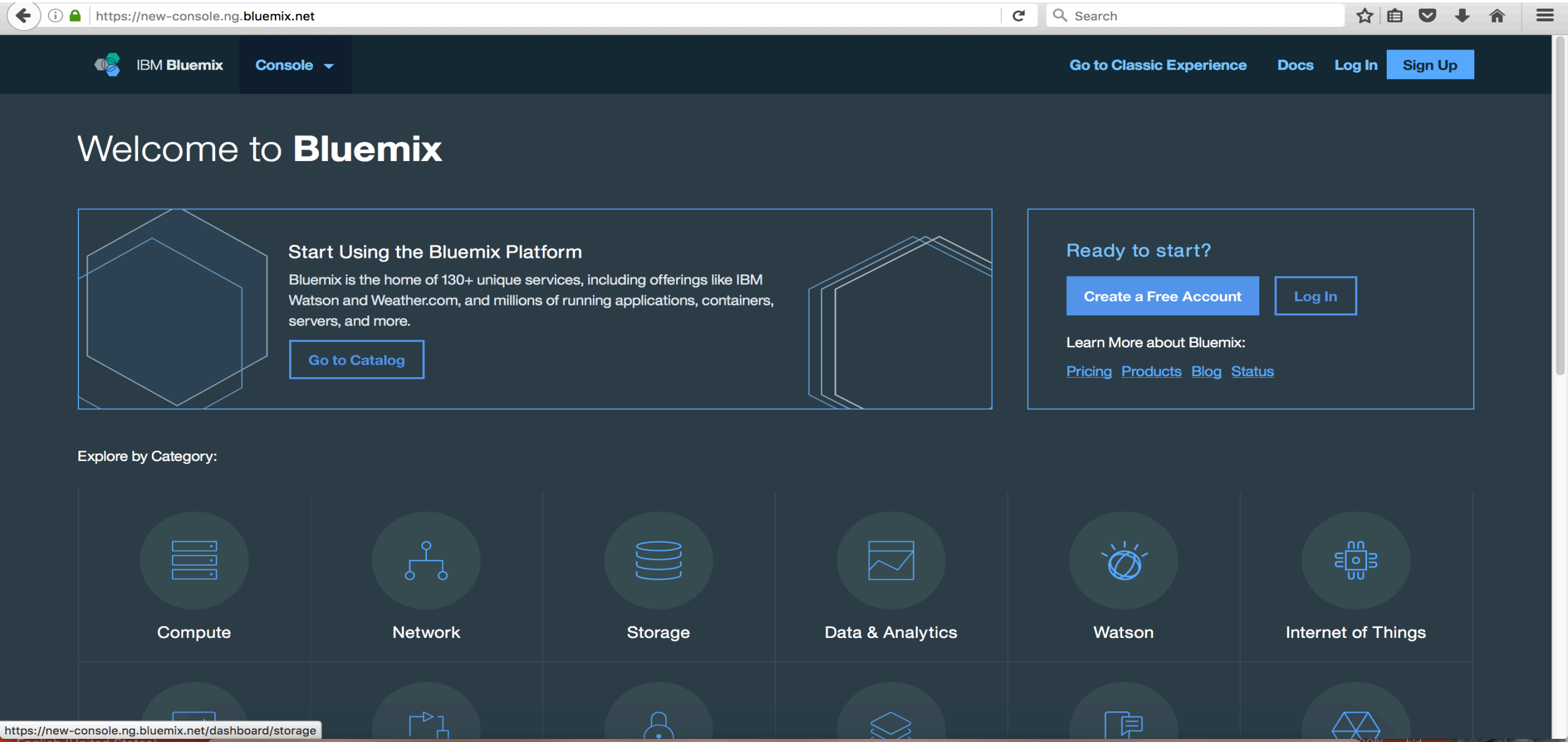
Foster the Community: Big Data University



Foster the Community: Data Science Experience



Foster the Community: Bluemix



Apache Spark Use Cases

Use Case: SolutionInc

IBM

SolutionInc

Business challenge

Wi-Fi provider SolutionInc wanted to give its clients insight into user engagement with public Wi-Fi spots. To extract value from its Wi-Fi network data, SolutionInc needed a new analytics capability.

Transformation

SolutionInc uses IBM's managed Spark service, IBM Analytics for Apache Spark, to mine network activity data that reveals customer behavior as customers visit and move between different locations.

Glen Lavigne
President and Chief Executive Officer
SolutionInc

Business benefits:

241 million
data sets analyzed and visualized rapidly in the cloud

Enables
the development of new location-based analytics services

Supports
better design decisions to adapt locations to customer needs

SolutionInc

Rapid big data analytics opens up new business opportunities

SolutionInc is a leader in managing public Internet access in hotels, convention centers, airports, coffee shops and other public venues around the world. The company offers on-premise and cloud-based solutions to provide high-demand public Wi-Fi solutions, enhancing the overall customer experience.

"Data analytics help customers translate investments in Wi-Fi solutions into a valuable business tool."

Glen Lavigne
President and Chief Executive Officer
SolutionInc

Share this

Use Case: Sensitel

IBM

SENSITEL

Business challenge

Many retailers suffer from the same headache. When a shopper enters a store seeking advice, if they cannot find a sales assistant quickly, they leave empty-handed – and the store loses out on a sale.

Transformation

Sensitel SENS analyzes sensor, Wi-Fi, and video data to recognize shoppers' faces and track their in-store locations, helping retailers send staff to serve people who need help, and make personalized offers.

Ray Sikka
CEO
Sensitel

Business benefits:

Recognizes
faces and anonymizes visit patterns, enabling 1-on-1 marketing and service

Accelerates
insight, enabling real-time decision-making while customers are in-store

Increases
sales by an estimated 5% for every 10% increase in staff engaging with customers

Sensitel

Harnessing analytics to deliver a smarter shopping experience

Sensitel specializes in leveraging Internet of Things (IoT) and big data technologies to help companies make smarter decisions and deliver excellent customer experiences. The firm is based in Santa Clara, California.

"IBM is helping us develop innovative IoT solutions that will change the face of entire industries."

Ray Sikka
CEO
Sensitel

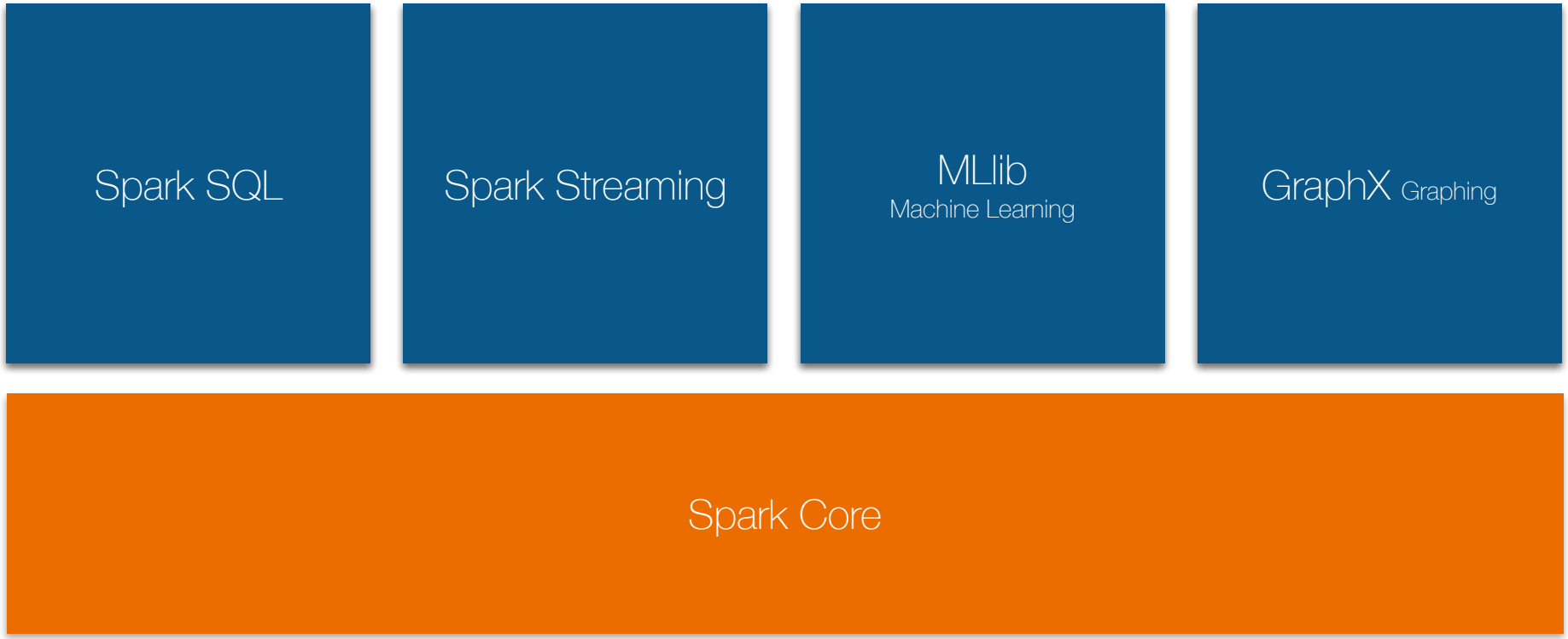
Share this

What is Apache Spark?

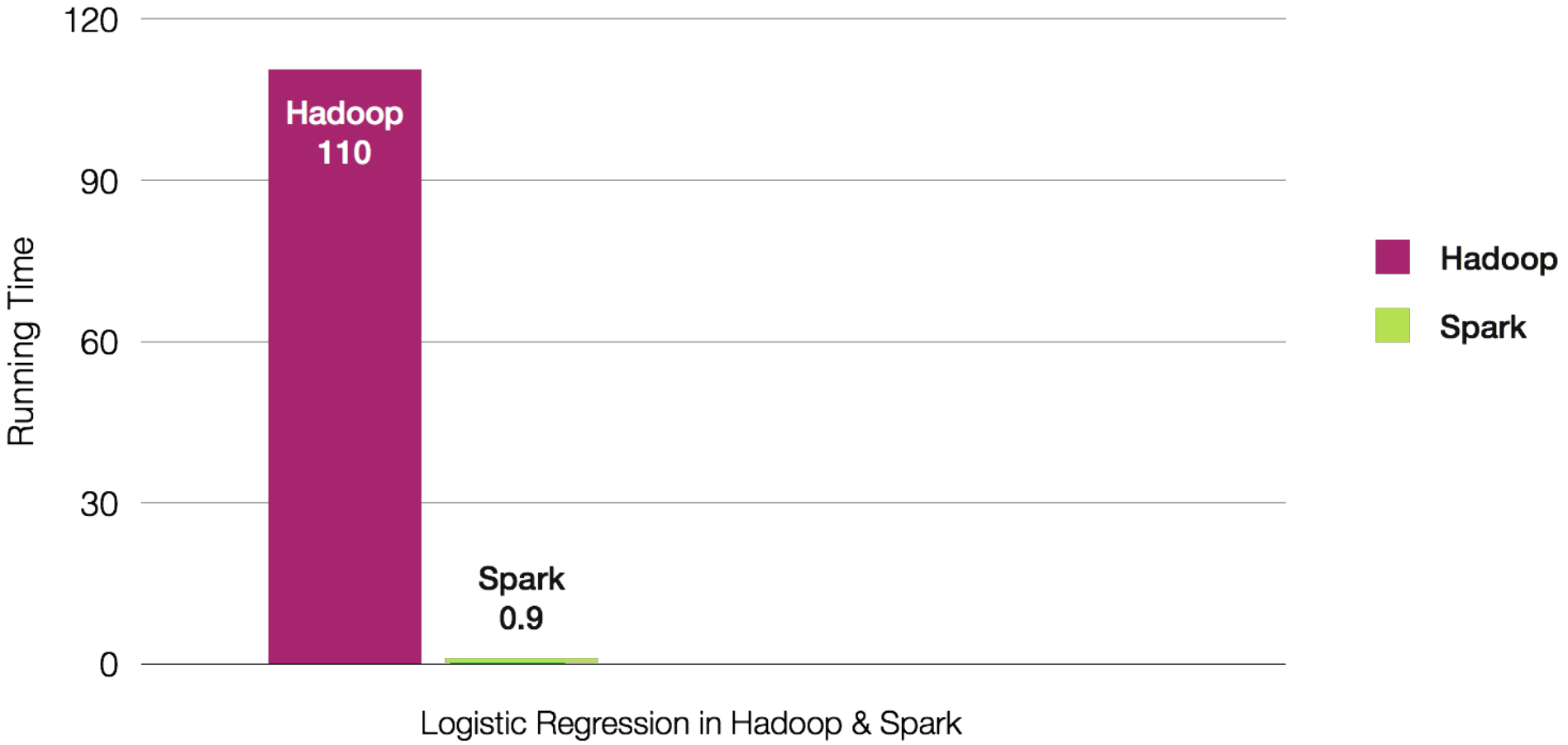
Introducing Apache Spark

- **General purpose distributed data processing engine**
- **AMPLab at UC Berkeley**
  - Started by Matei Zaharia in 2009
  - Creators founded Databricks
    - IBM partners with DB
- **Apache open source project**
  - Initial release May 2014
  - Current version 2.0.2 released November 2016

Spark and the Key Libraries



Why Spark? Performance



Why Spark? Productive

- Production ready code
- Concise
- Focus on the business problems
- and not coding

Example: WordCount v1.0

Before we jump into the details, lets walk through an example MapReduce application to get a flavour for how they work.

`WordCount` is a simple application that counts the number of occurences of each word in a given input set.

This works with a local-standalone, pseudo-distributed or fully-distributed Hadoop installation (Single Node Setup).

Source Code

WordCount.java

```
package org.myorg;

import java.io.IOException;
import java.util.*;

import org.apache.hadoop.fs.Path;
import org.apache.hadoop.conf.*;
import org.apache.hadoop.io.*;
import org.apache.hadoop.mapred.*;
import org.apache.hadoop.util.*;

public class WordCount {

  public static class Map extends MapReduceBase implements Mapper<LongWritable, Text, Text, IntWritable> {
    private final static IntWritable one = new IntWritable(1);
    private Text word = new Text();

    public void map(LongWritable key, Text value, OutputCollector<Text, IntWritable> output, Reporter reporter) throws IOException {
      String line = value.toString();
      StringTokenizer tokenizer = new StringTokenizer(line);
      while (tokenizer.hasMoreTokens()) {
               kenizer.nextToken());
               ect(word, one);

               class Reduce extends MapReduceBase implements Reducer<Text, IntWritable, Text, IntWritable> {
               educe(Text key, Iterator<IntWritable> values, OutputCollector<Text, IntWritable> output, Reporter reporter) throws IOException {

               s.hasNext()) {
               es.next().get();

               ct(key, new IntWritable(sum));

               void main(String[] args) throws Exception {
               = new JobConf(WordCount.class);
               me("wordcount");

               tKeyClass(Text.class);
               tValueClass(IntWritable.class);

    conf.setMapperClass(Map.class);
    conf.setCombinerClass(Reduce.class);
    conf.setReducerClass(Reduce.class);

    conf.setInputFormat(TextInputFormat.class);
    conf.setOutputFormat(TextOutputFormat.class);

    FileInputFormat.setInputPaths(conf, new Path(args[0]));
    FileOutputFormat.setOutputPath(conf, new Path(args[1]));

    JobClient.runJob(conf);
  }
}
```

Word Count

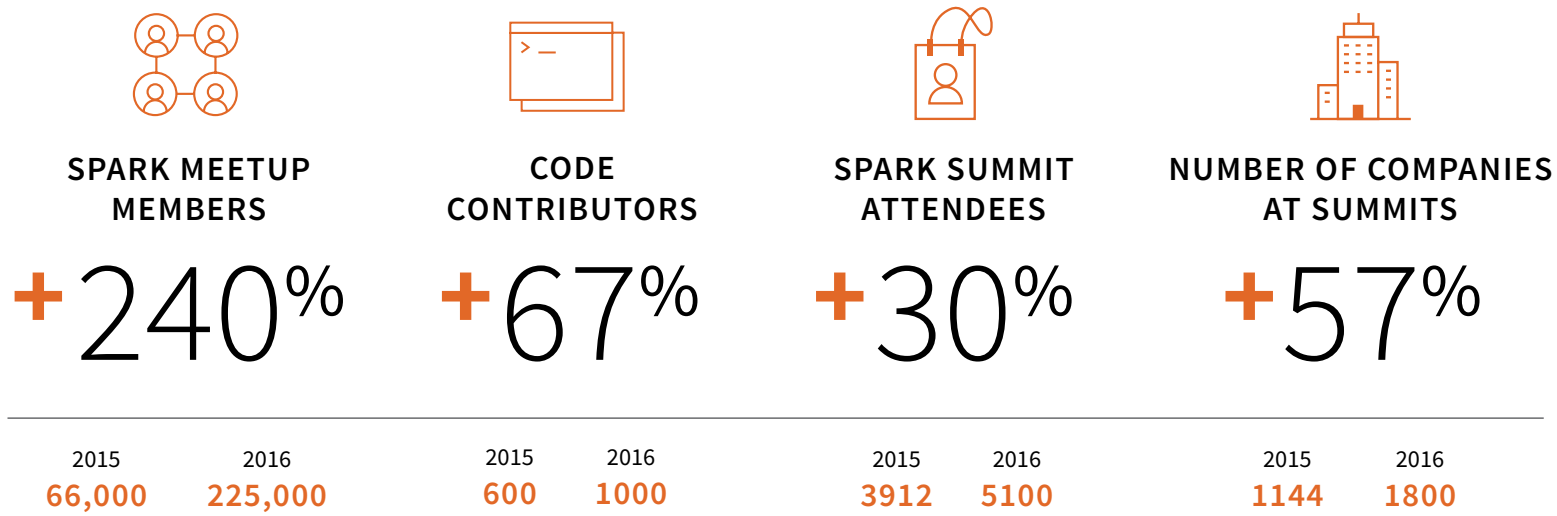
In this example, we use a few transformations to build a dataset of (String, Int) pairs called `counts` and then save it to a file.

Python | Scala | Java

```
text_file = sc.textFile("hdfs://...")
counts = text_file.flatMap(lambda line: line.split(" ")) \
             .map(lambda word: (word, 1)) \
             .reduceByKey(lambda a, b: a + b)
counts.saveAsTextFile("hdfs://...")
```

Why Spark? Community

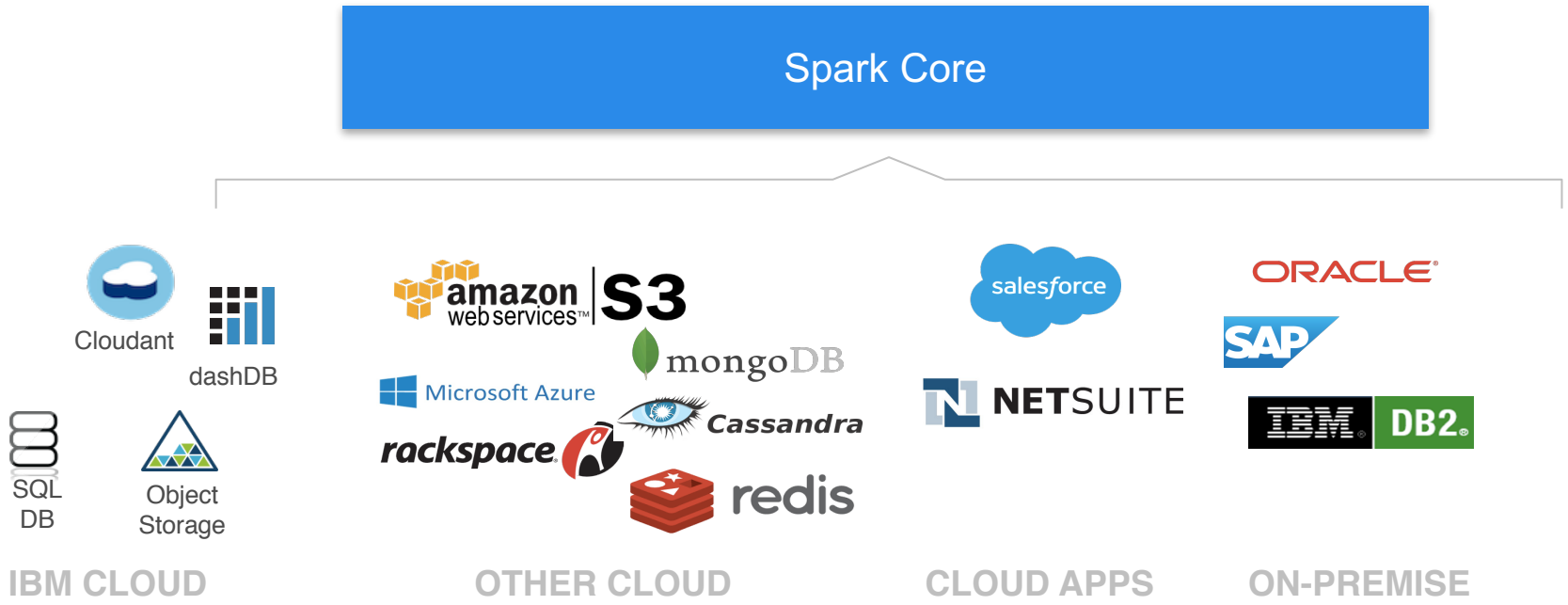
- **Open source community**
- **Fastest growing**
- **Wide adoption**



source: DataBricks 2016 Survey

Why Spark? Ease of Use

- Four APIs
- Documentation
- Data Platform Flexibility



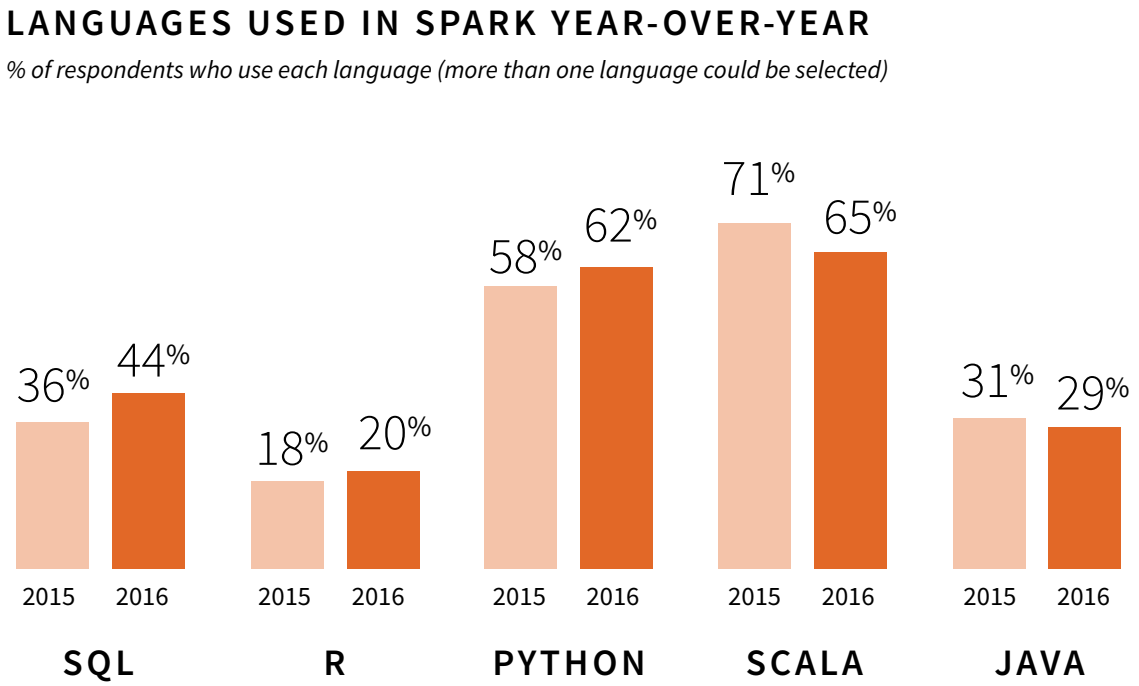
What Spark Is Not

- **Not *only* for Hadoop** – Spark can work with Hadoop (especially HDFS), but Spark is a standalone system
- **Not a data store** – Spark attaches to other data stores but does not provide its own
- **Not *only* for machine learning** – Spark includes machine learning and does it very well, but it can handle much broader tasks equally well
- **Not real time** – Spark Streaming is micro-batching, not true streaming, and cannot handle the real-time complex event processing

Apache Spark Programming

Spark Programming Languages

- **Scala**
  - Functional programming
  - Spark written in Scala
  - Scala compiles into Java byte code
- **Python**
  - Easily ports to Spark
- **Java**
  - New features in Java 8 makes for more compact coding
- **R**
  - Statistical language used to create and manipulate data



source: DataBricks 2016 Survey

Functional Programming

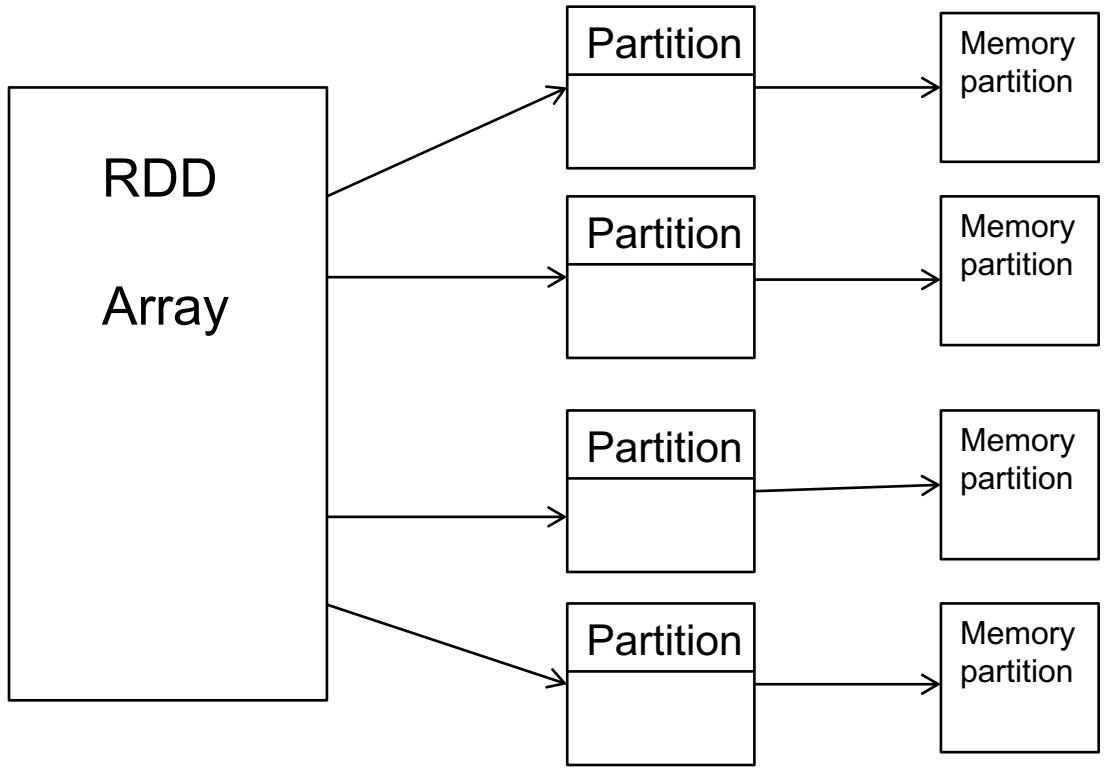
- **Spark depends on functional programming**
- **Closures or in line anonymous functions**
  - Functions have inputs and outputs only
  - One can pass functions as inputs to other functions as parameters

- **Python**
  - function(lambda x: x)

- **Scala**
  - function(x => x)

Resilient Distributed Dataset (RDD)

- **Immutable**
- **Holds references to partition objects**
- **Each partition is a subset of the overall data**
- **Partitions are assigned to nodes on the cluster**
- **Partitions are in memory by default**
- **Fault tolerance**
  - If data in memory is lost it will be recreated from lineage



DataFrames

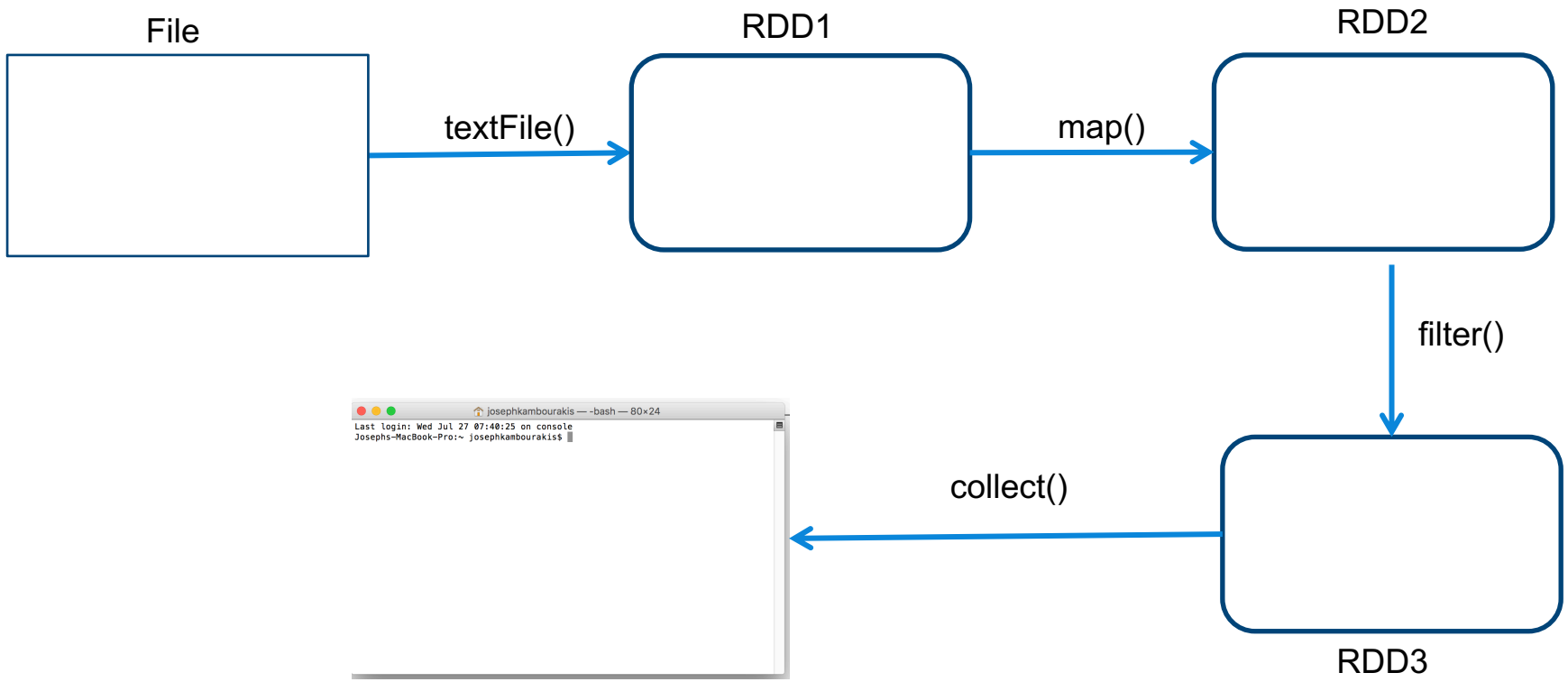
- **Subset of RDDs**
- **Main data object abstraction in SparkSQL**
  - Organized into NAMED columns
- **Can be created from:**
  - Existed structured data source
    - json, database table, Apache Parquet
  - Another RDD
  - Transformation of another dataframe
  - Programmatically

More about RDDs and DFs

- Two types of operations
  - Transformations
    - map()
    - filter()
    - flatMap()
  - Actions
    - first()
    - collect()
    - take()
- Lazy evaluation

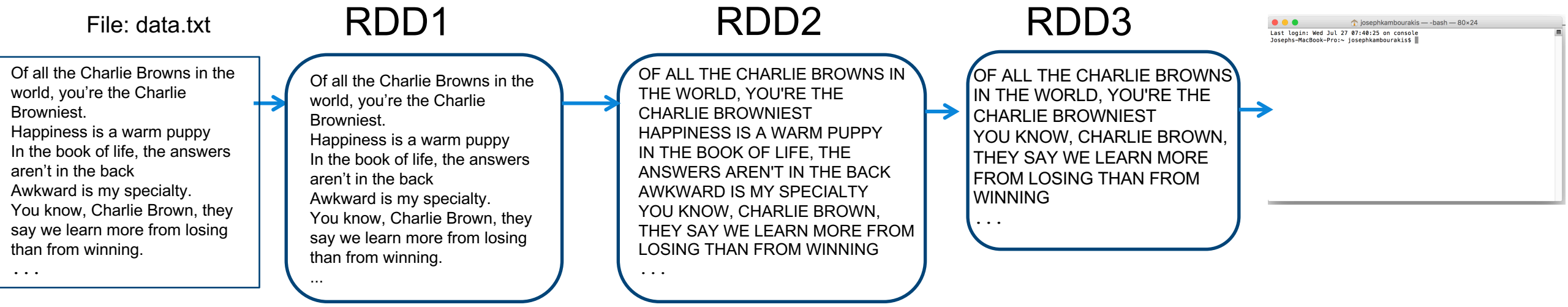
Apache Spark Code Execution

Directed Acyclic Graph - DAG



Sample Code

- **RDD1 = sc.textFile(data.txt)**
  RDD2 = RDD1.map(lambda line: line.upper())
  RDD3 = RDD2.filter(lambda line: 'CHARLIE' in line)
  RDD3.collect()

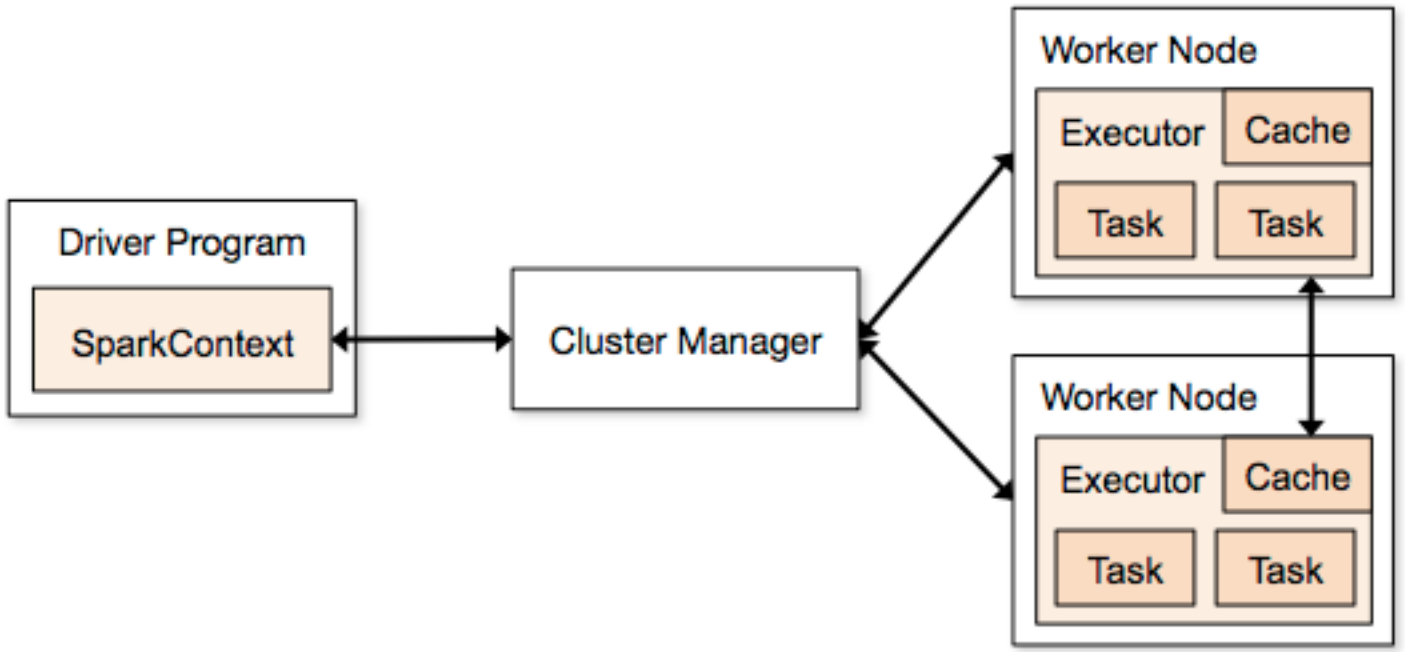


Apache Spark Under the hood!

Spark Application Architecture

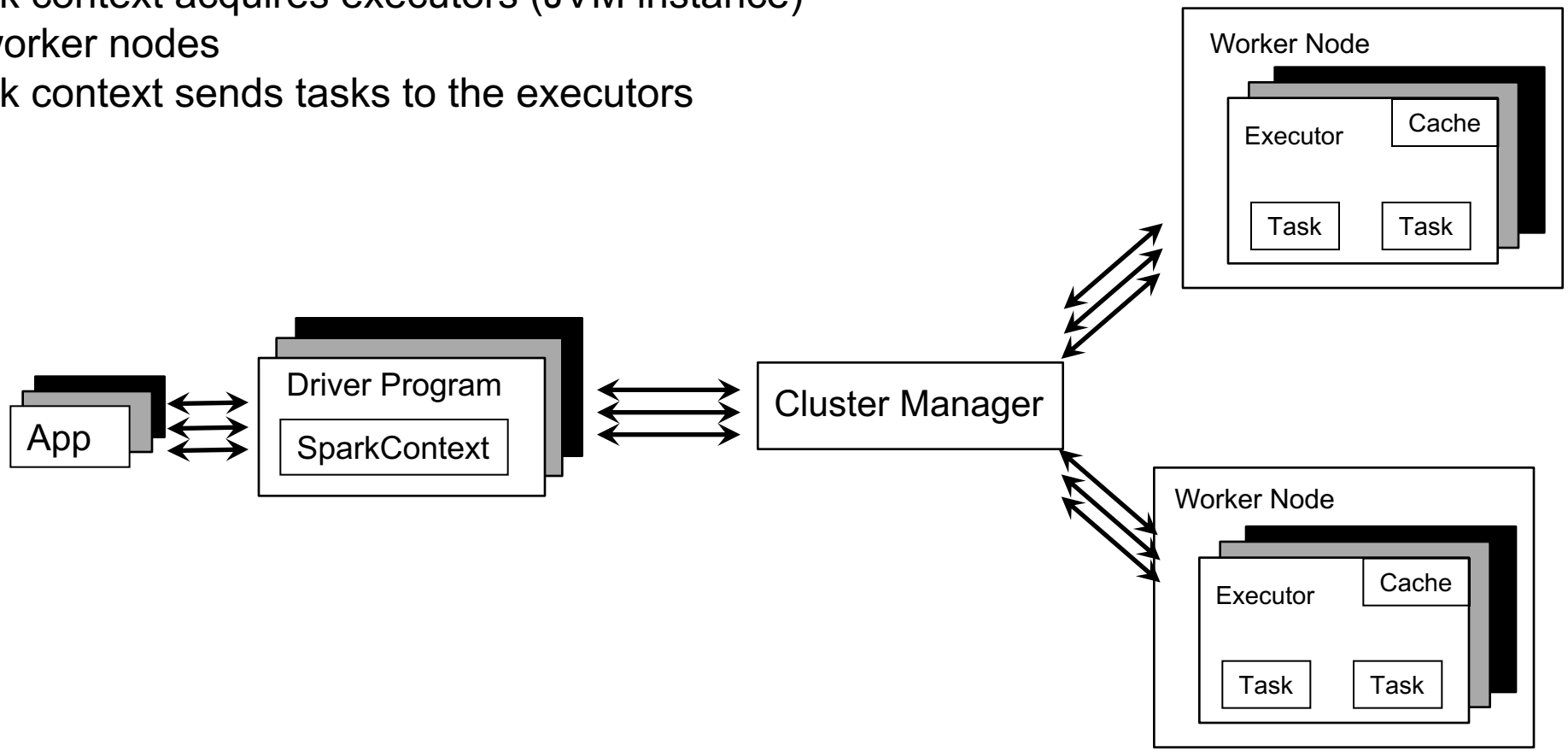
- **A Spark application is initiated from a driver program**

- **Spark execution modes:**
  - Standalone with the built-in cluster manager
  - Use Mesos as the cluster manager
  - Use YARN as the cluster manager
  - Standalone cluster on any cloud (BlueMix, IBM Softlayer, Amazon, Azure, …)

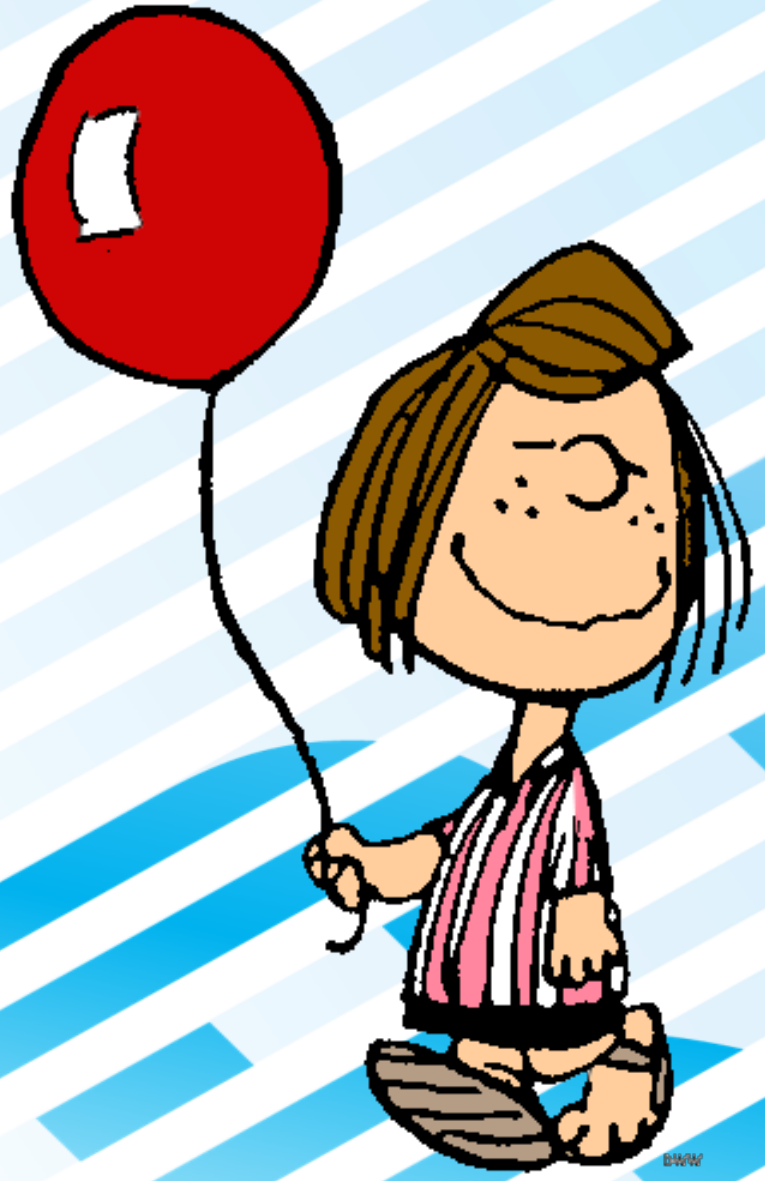


Showing multiple applications

- Each Spark application runs as a set of processes coordinated by the Spark context object (driver program)
  - Spark context connects to Cluster Manager (standalone, Mesos/Yarn)
  - Spark context acquires executors (JVM instance) on worker nodes
  - Spark context sends tasks to the executors



Apache Spark Libraries



SparkSQL

- **Component of Spark**
  - Project started in 2012
  - First alpha release in Spring 2013
  - Out of alpha with Spark 0.9.0
  - New features in Spark 2.0
- **Allows you to interact with Apache Hive**

- **More in next section!**

Spark Streaming

- **Component of Spark**
  - Project started in 2012
  - First alpha release in Spring 2013
  - Out of alpha with Spark 0.9.0
  - New features in Spark 2.0

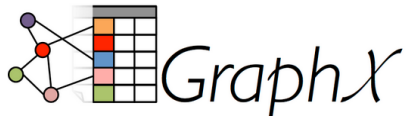
- **Discretized Stream (DStream) programming abstraction***
  - Represented as a sequence of RDDs (micro-batches)
  - RDD: set of records for a specific time interval
  - Supports Scala, Java, and Python (with limitations)

- **Fundamental architecture: batch processing of datasets**

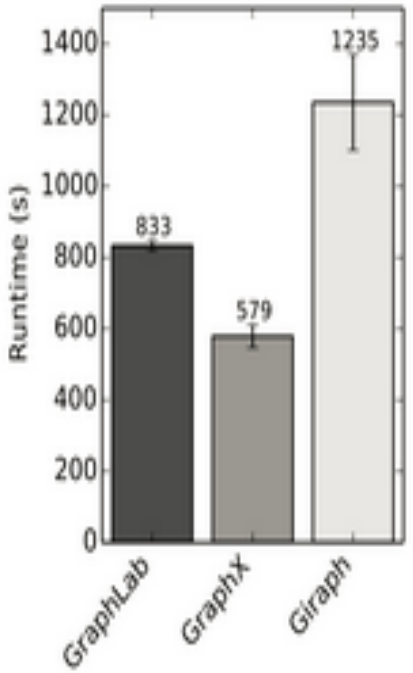
Spark MLlib

- **Spark MLlib for machine learning library**
- **Provides common algorithm and utilities**
  - Classification
  - Regression
  - Clustering
  - Collaborative filtering
  - Dimensionality reduction
- **Leverages iteration and yields better results than one-pass approximations sometimes used with MapReduce**
- **More on this later!**

Spark GraphX

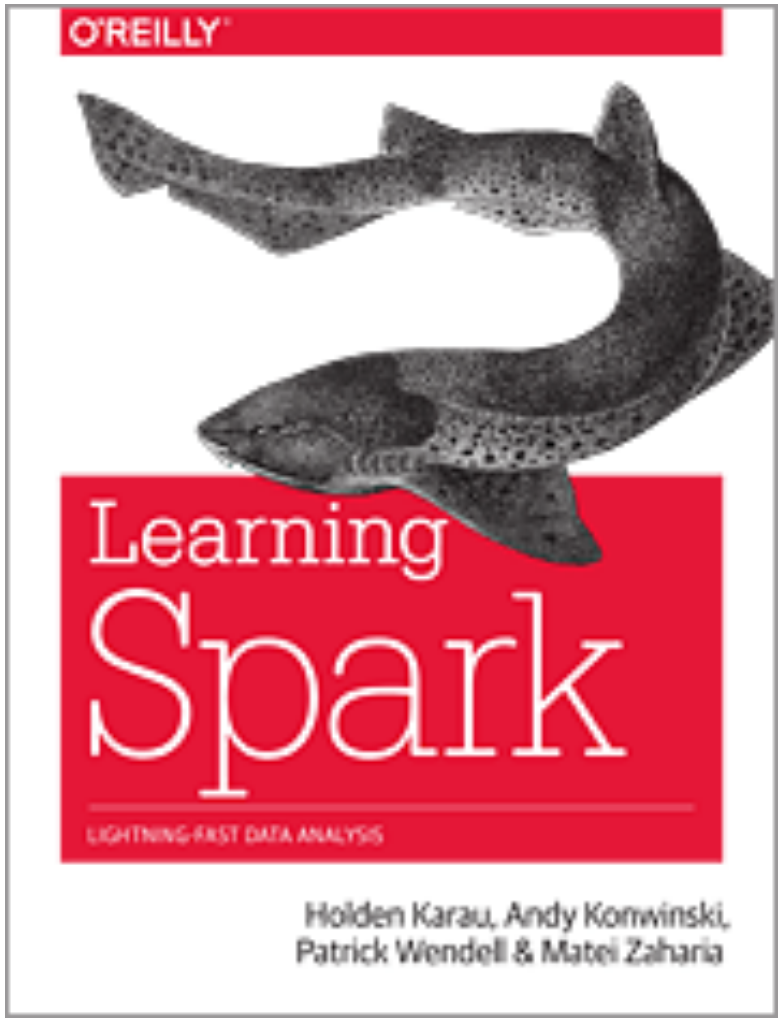


- **Scala only!**
- **Flexible Graphing**
  - GraphX unifies ETL, exploratory analysis, and iterative graph computation
  - You can view the same data as both graphs and collections, transform and join graphs with RDDs efficiently, and write custom iterative graph algorithms with the API
  - GraphFrames - graph library based on Data Frames
- **Speed**
  - Comparable performance to the fastest specialized graph processing systems.
- **Algorithms**
  - Choose from a growing library of graph algorithms
  - In addition to a highly flexible API, GraphX comes with a variety of graph algorithms

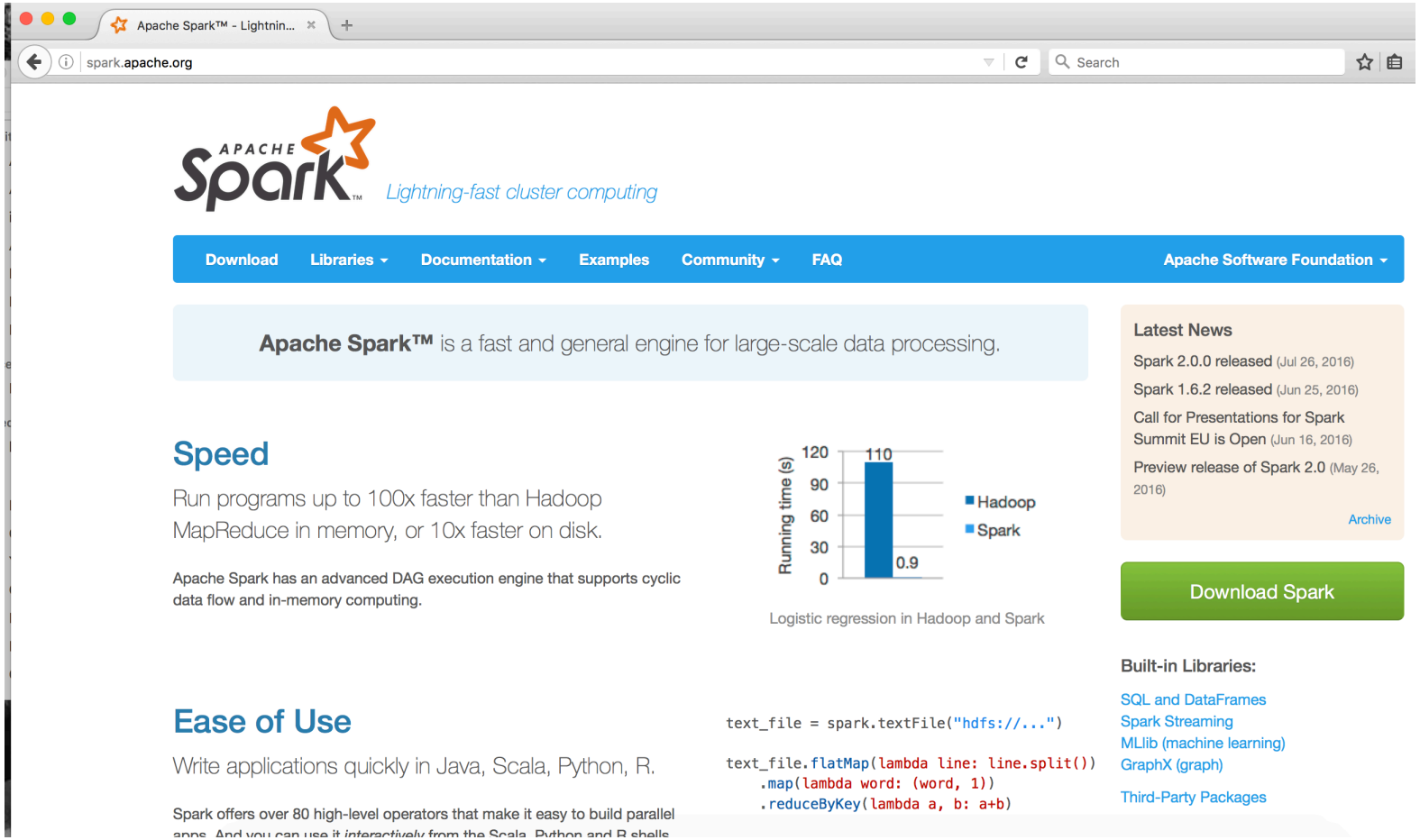


Apache Further Resources

Additional Resources



Additional Resources



Intro to lab

- **Data Science Experience**
  - Jupyter Notebook
- **Student Code**
  - Solutions will be provided after the lab and we'll walk through them.

Intro to lab

Figure 1. Magic Quadrant for Data Science Platforms

Source: Gartner (February 2017)

Links to Material

- **Box**
  - https://ibm.box.com/v/MetLife
- **Github**
  - https://github.com/JosephKambourakisIBM/Metlife