Aalto University
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CS-E4610
Modern Database Systems
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Tutorial 03
Spark for batch and streaming processing

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Agenda

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Spark at a Glance

- Summary from lecture 09
- Spark Applications
- Spark's APIs: Low-level API, high-level structured API

Getting Started

- The SparkSession
- Spark UI

Spark's low-level API

- RDD
  - Transformations (Lazy)
  - Actions (Eager)
  - Reduction Operations
  - Pair RDDs
  - Join
- Shuffling and Partitioning
- Streaming Context and DStream

Spark's high-level structured API

- SQL and DataFrame

In the previous lecture:

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Spark is a distributed big data processing framework.

- Distribution brings new concerns: Node failure and latency

Uses Resilient Distributed Datasets (RDD) to distribute and parallelize the data.

- RDDs are ***lazily-created*** and ***ephemeral***
- Caching and persistence is used to preserve a RDD in memory, disk, or both

RDDs are fault tolerant

- Able to recover the state of an RDD using **coarse-grained transformations** and **lineage.**

Transformations are **lazy** (e.g., map, filter, groupBy, sortBy, reduceByKey)

Actions are **eager** (e.g., take, collect, reduce, first, foreach)

The topology of the cluster matters

Working with RDDs implies **shuffling** and **partitioning**

- Impact on performance due to latency

Spark provides Big Data Streaming processing via **DStreams**

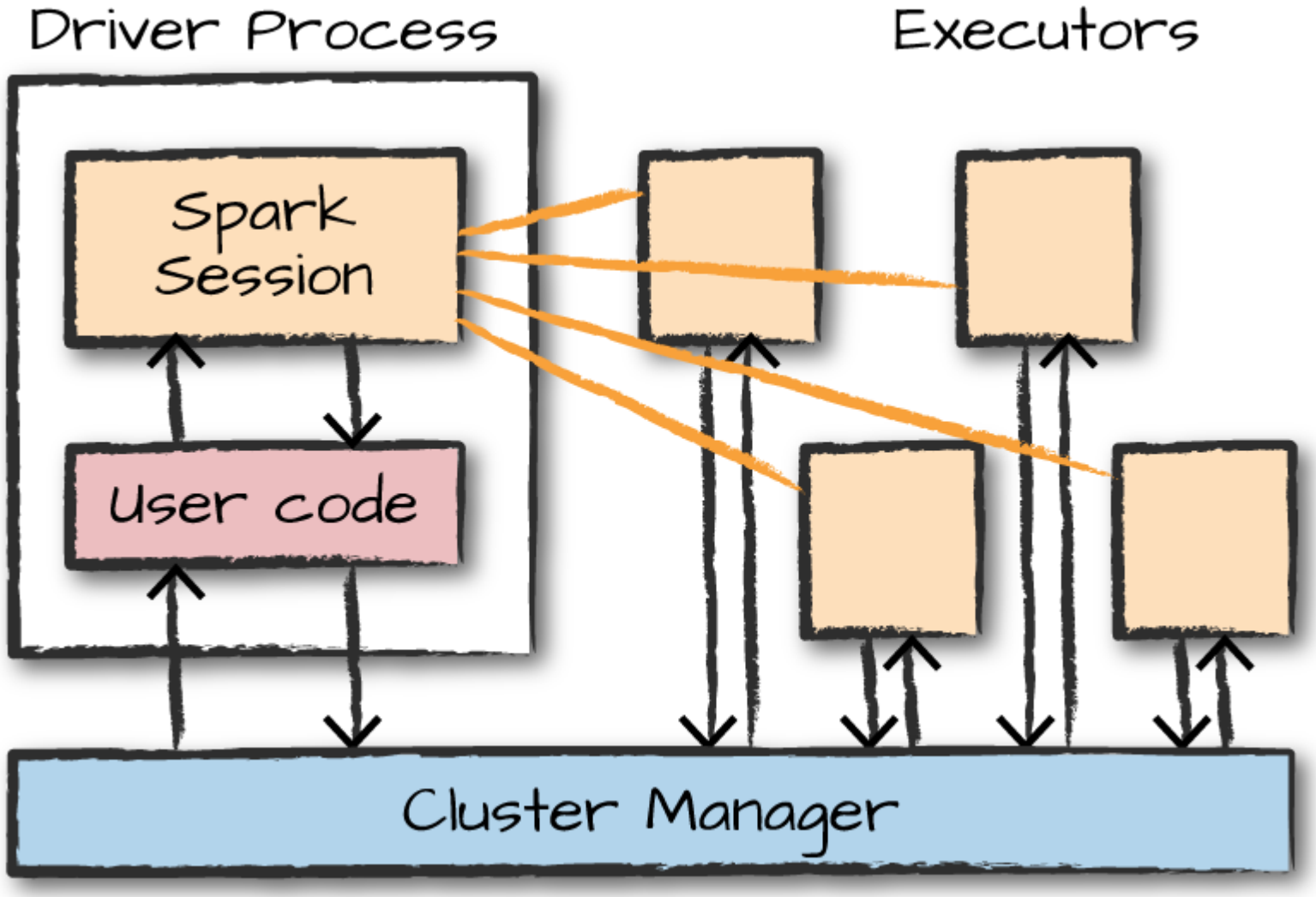
Spark Architecture

Driver:

- Maintains information about the Spark Application.
- Responding to a user's program or input.
- Analyzing, distributing, and scheduling work across the executors.

Executors:

- Executing code.
- Reporting the state of the computation.

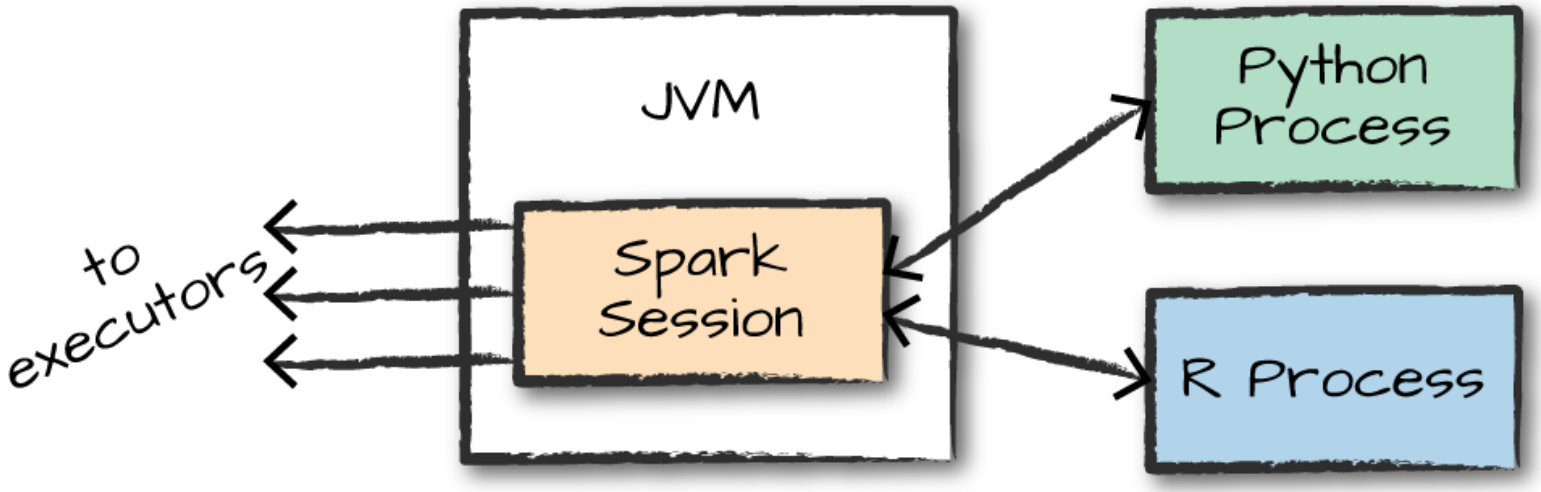


Spark APIs

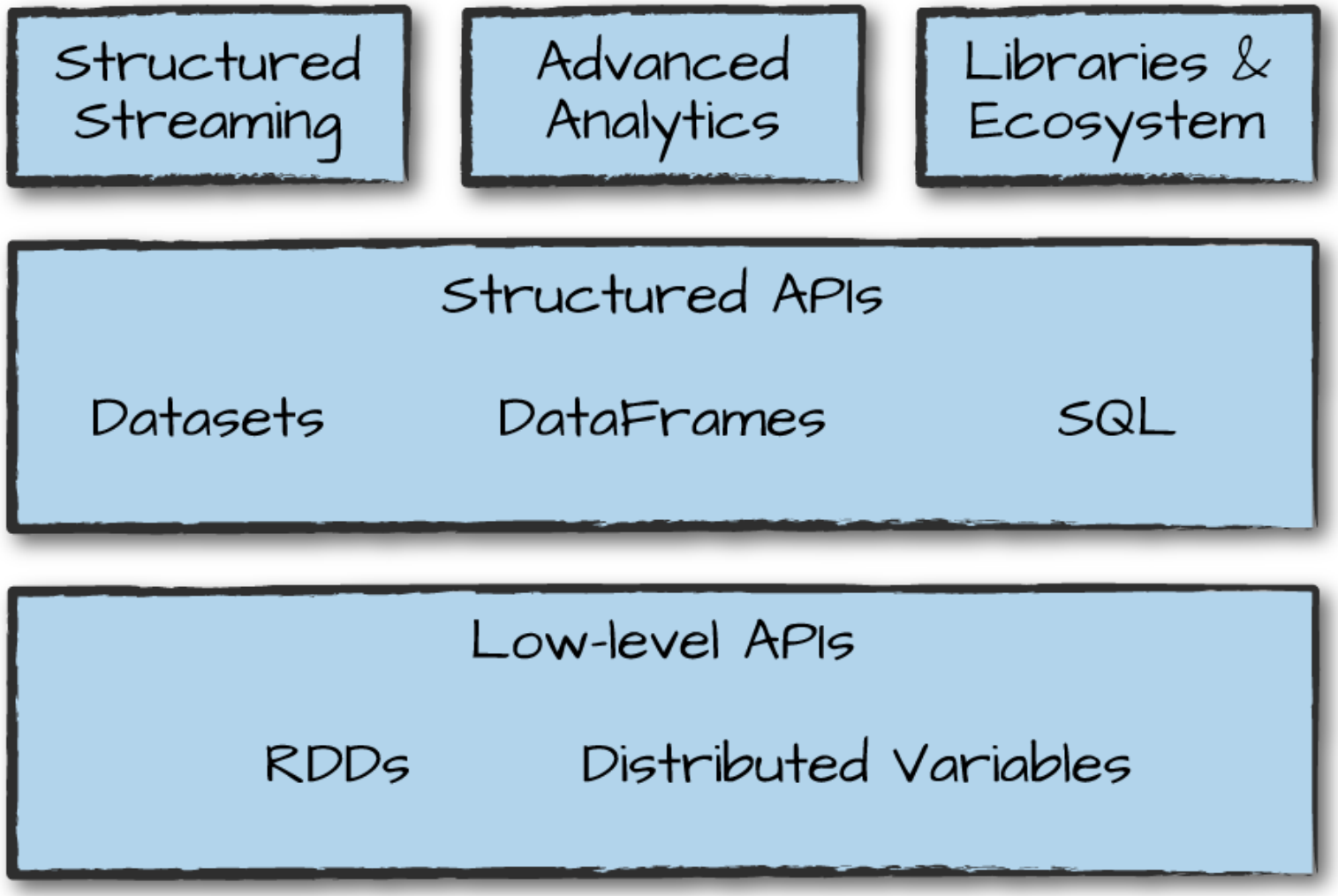
Available in many languages:
Scala, Java, Python, R.

These APIs offer a **SparkSession** for running Spark code:

- This is the driver
- Executes user-defined manipulations across the cluster.
- One-to-one correspondence between a SparkSession and a Spark Application.



Spark's toolset



Hands-on: Getting started, RDDs, and Dstreams
https://github.com/frederickayala/mds2018/

Issues with RDDs

As developers, we use RDDs to tell Spark **how** to do transformations and actions. Spark will do as we instruct.

Spark cannot optimize our transformations because does not know **what** we are doing.

What is in an RDD?

Dependencies

Partitions (with optional locality info)

Compute function: **Partition => Iterator[T]**

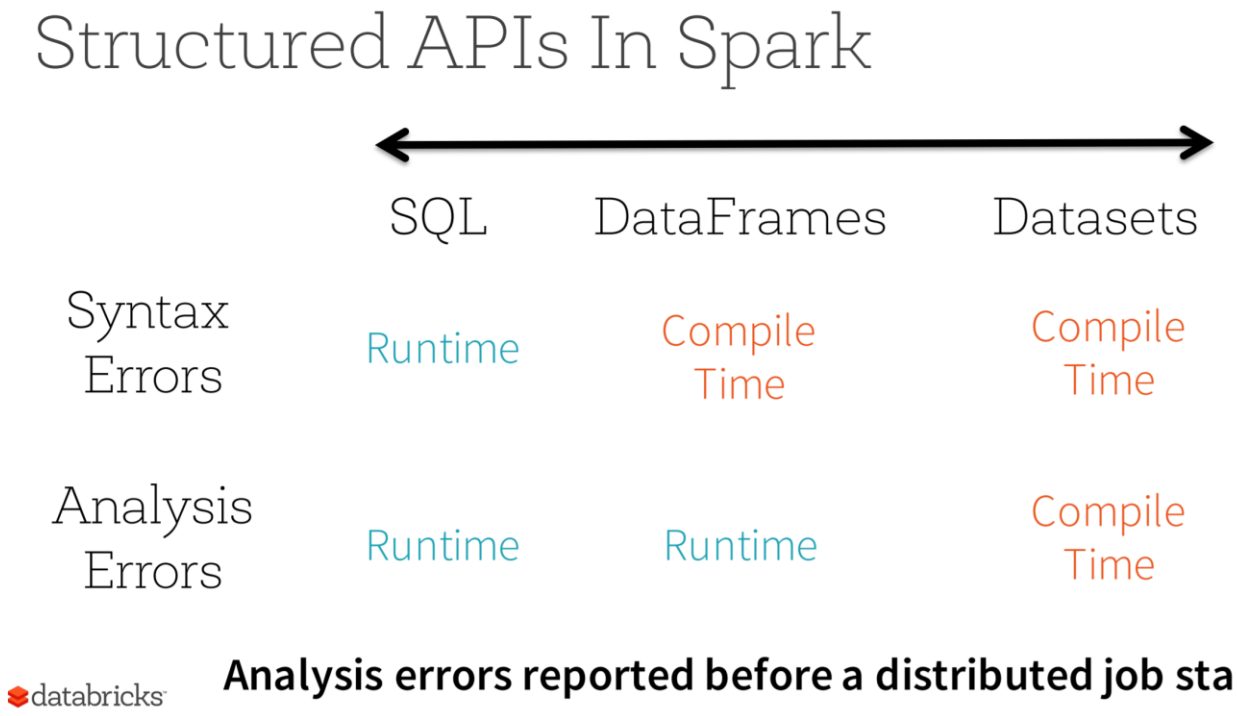
- **Partition => Iterator[T]:** Opaque computation
- **[T]:** Opaque data

Structured APIs

Help us to express what we want to achieve.

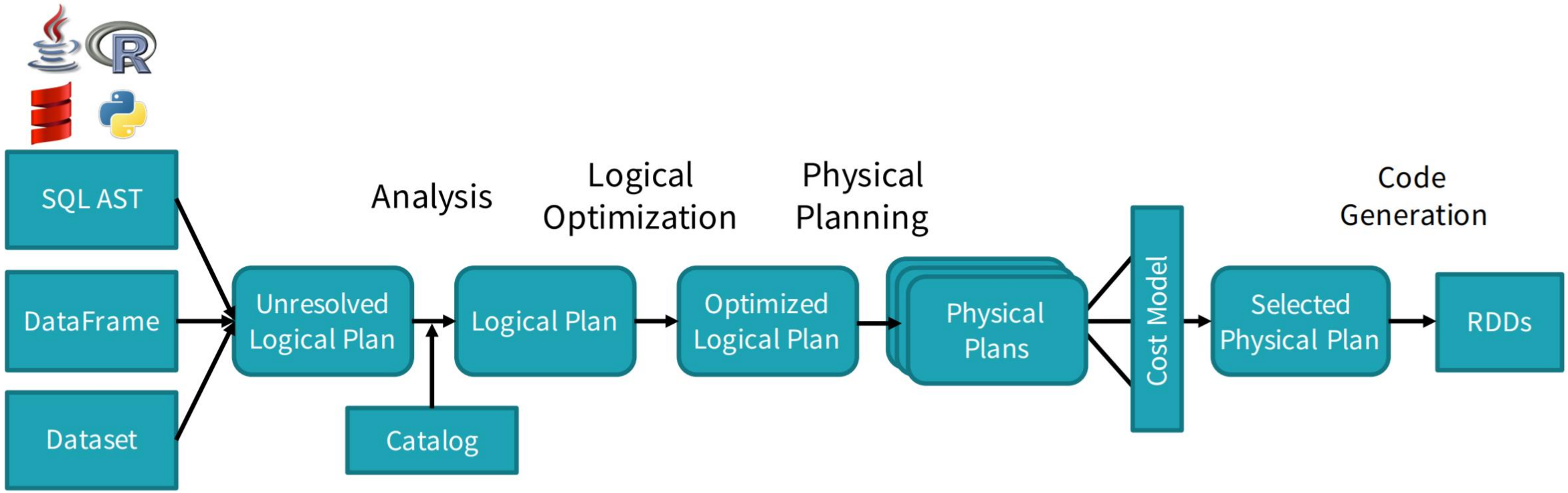
By doing this, Spark understands the goal and is able to optimize the execution plan.

Moreover, it can help us to find errors before execution!



DataFrame = Dataset[Row]

Shared Optimization & Execution



DataFrames, Datasets and SQL
share the same optimization/execution pipeline

databricks

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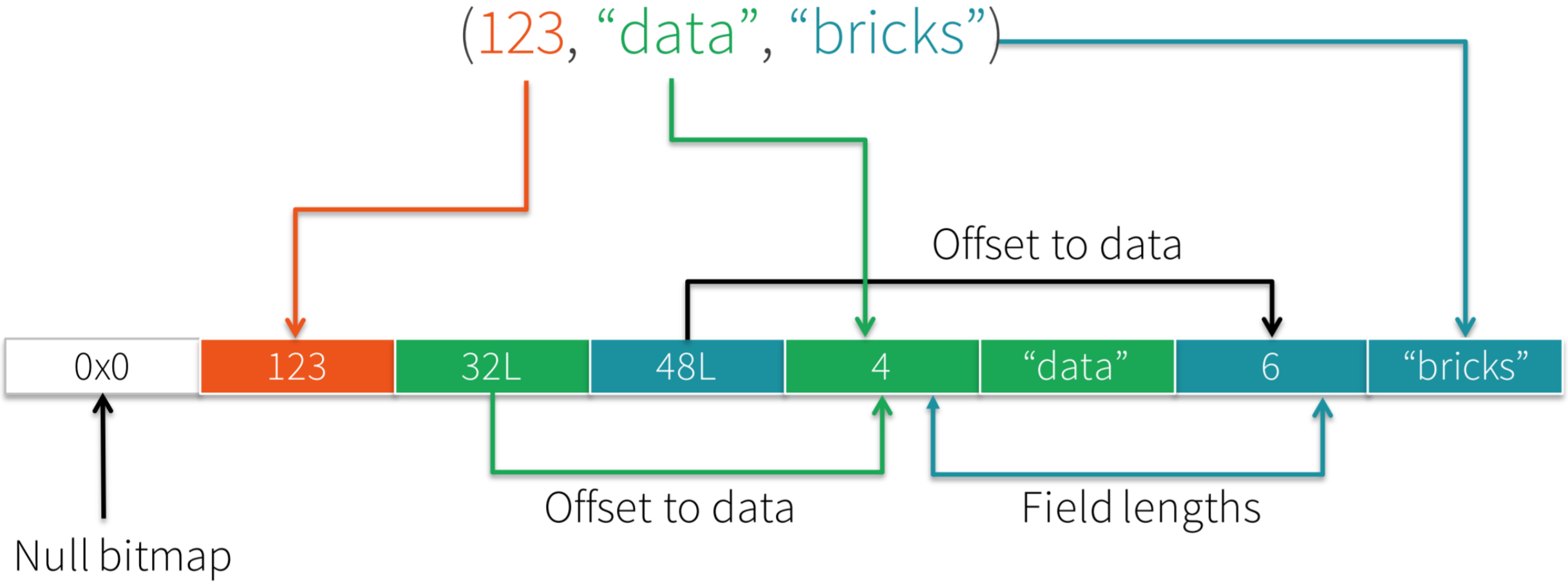
Tungsten's Compact Encoding



Tungsten's compact encoding improves efficiency

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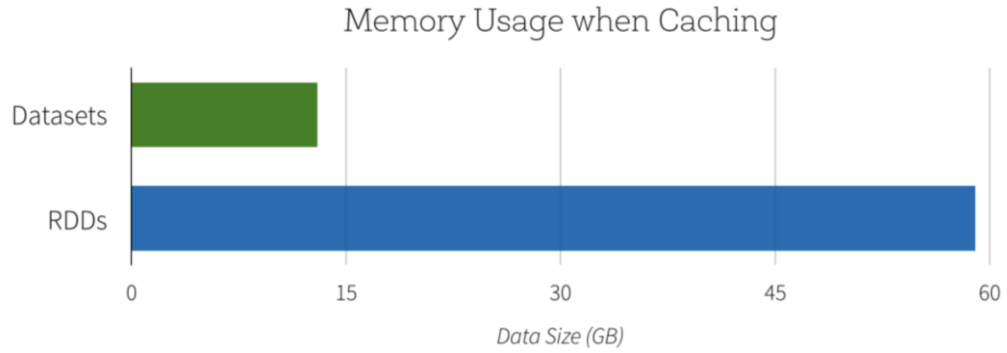
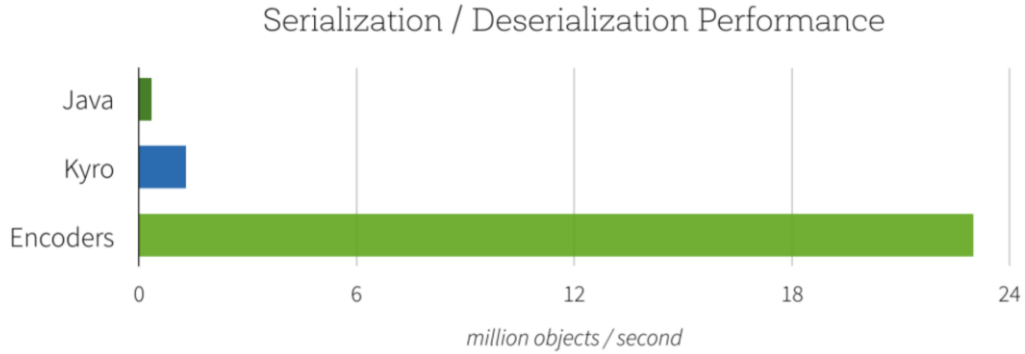
Space Efficiency

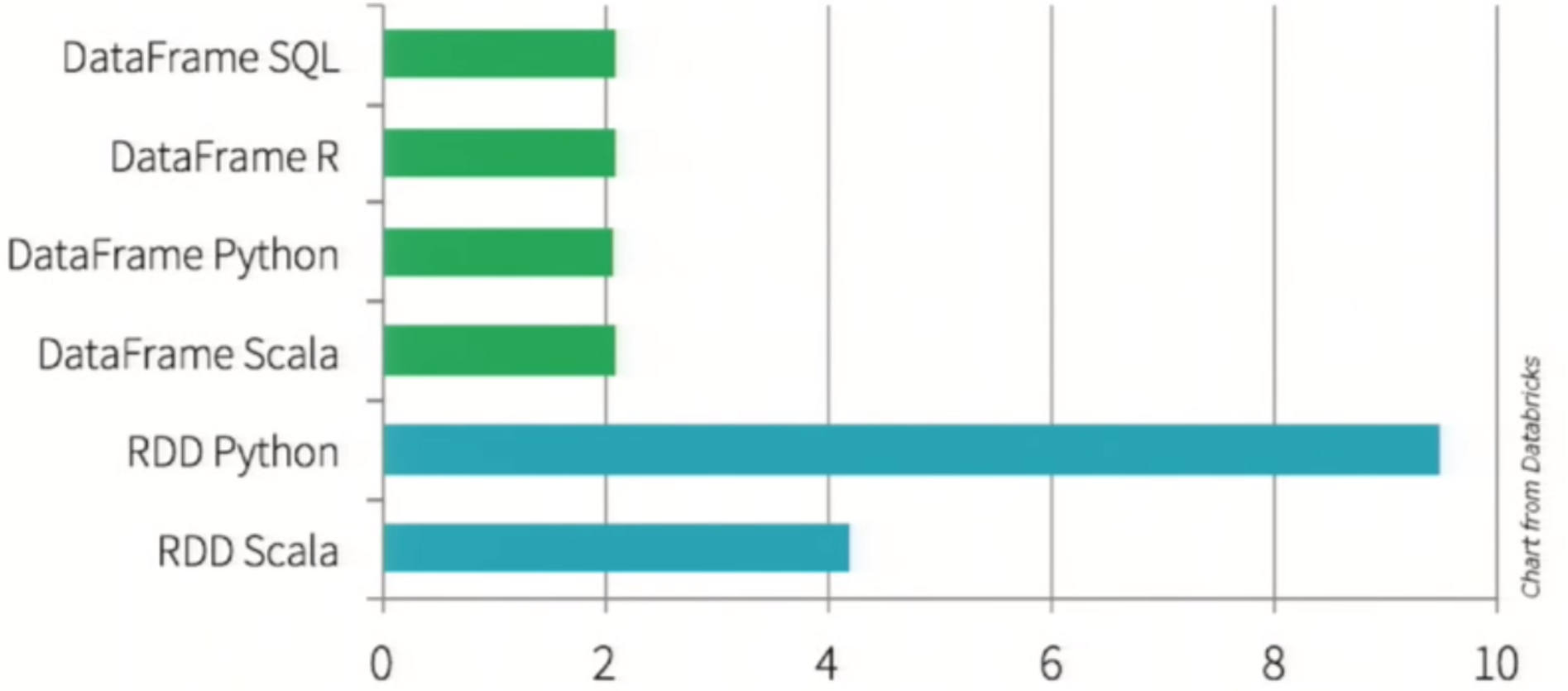


Serialization performance



DataFrames are faster

Because of the optimization, they tend to outperform RDDs.



Hands-on: SQL and DataFrame
https://github.com/frederickayala/mds2018/

That’s all!

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Thanks!

Questions?

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Credits and References

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- **Learning Spark** by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia (O'Reilly). Copyright 2015 Databricks, 978-1-449-35862-4.
- **Spark: The Definitive Guide** by Bill Chambers and Matei Zaharia (O'Reilly). Copyright 2018 Databricks, Inc., 978-1-491-91221-8."
- **Structuring Apache Spark SQL, DataFrames, Datasets, and Streaming**, Michael Armbrust. Spark Summit 2016.