SparkR: Scaling R Programs with Spark

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amplab UC BERKELEY

databricks™

Why R ?

Statistics

data.frame

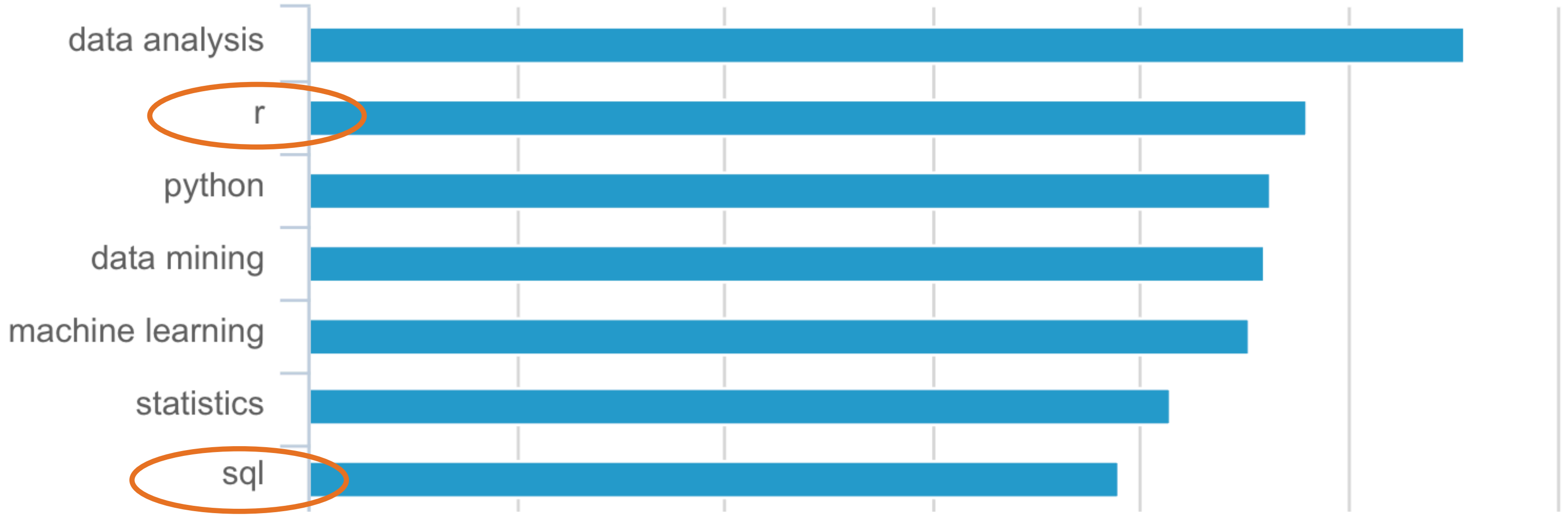
Visualization

CRAN packages

Implementation of “S”
Statistical computing language
(Bell Labs 1975)

Why R ?

TOP 20 SKILLS OF A DATA SCIENTIST



Source: https://rjmetrics.com/resources/reports/the-state-of-data-science/

Big Data & R

Statistics

data.frame

Visualization

CRAN packages

+

Data

Big Data & R: Challenges

Data access:

HDFS, Hive, S3

Capacity:

Single Machine Memory

Parallelism:

Single Thread

Approach

Approach 1: Parallel R API

Features

- Parallel R APIs `foreach,apply`
- Run custom R code, packages

Challenges:

- Efficiency, performance
- Functionality ?

Vertica Distributed R

RHIPE, RHadoop etc.

Approach 1: Parallel R API

```
# lines: list of strings
ints <- apply(lines,
             function(line) {
                 as.numeric(line[2])
             })
res <- sum(collect(Reduce(ints,
             function(x, y) {
               x + y
             })))
```

Convert string to integer

Add up results

Approach 2: High level API

Features:

- Wrappers over SQL / ML algorithms
- Reuse query optimization, codegen etc.
- Easy to use, develop

Challenges:

- Custom R code / packages ?

Spark SQL

Spark MLlib

SciDB

Approach 2: High level API

```
# lines: list of strings
linesDF <- as.DataFrame(lines)

res <- select(linesDF, sum(lines$age))
```

Convert to table

LINQ-style query

Execute using SQL engine

SparkR Design

User API

Architecture

SparkR User API

DataFrames + Machine Learning

SparkR DataFrames

DataSources API

Column Functions, Aggregations

Translate to Spark SQL

```
people <- read.df(
    “people.json”,
    “json”)

avgAge <- select(
    df,
    avg(df$age))

head(avgAge)
```

SparkR Machine Learning

```
model <- glm(
    a ~ b + c,
    data = df)
```

R Formulas

- Concise specification of ML problem
- Response `a` modeled by linear predictors `b,c`

```
summary(model)
```

Model Summaries

- Print coefficients, standard errors etc.
- Efficient distributed computation

SparkR UDFs

DataFrame UDFs, UDAFs

Run R functions on *partitions*

Users specify output schema

`dapply, gapply`

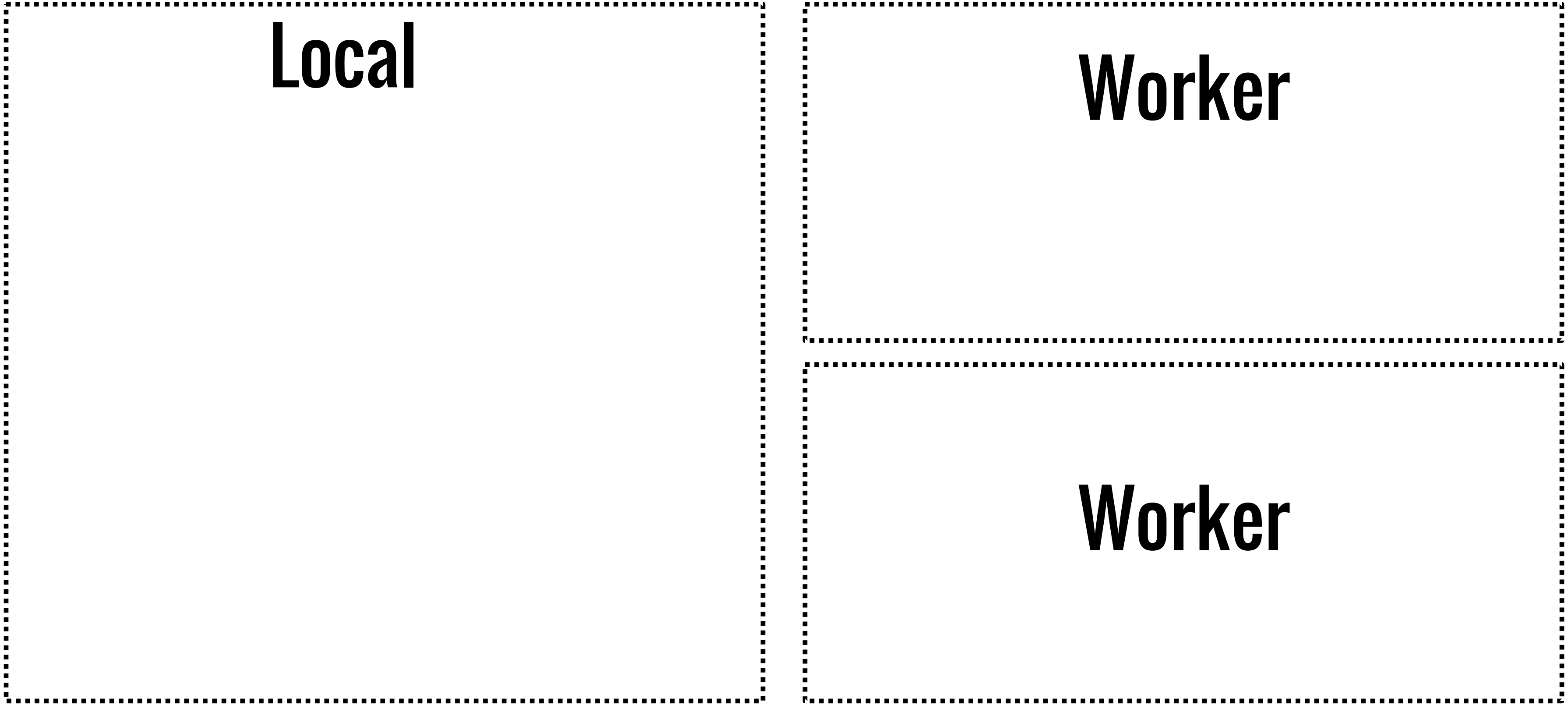
Partition Aggregate

Run R functions in parallel

Parameter tuning, Model averaging

`spark.lapply`

Architecture

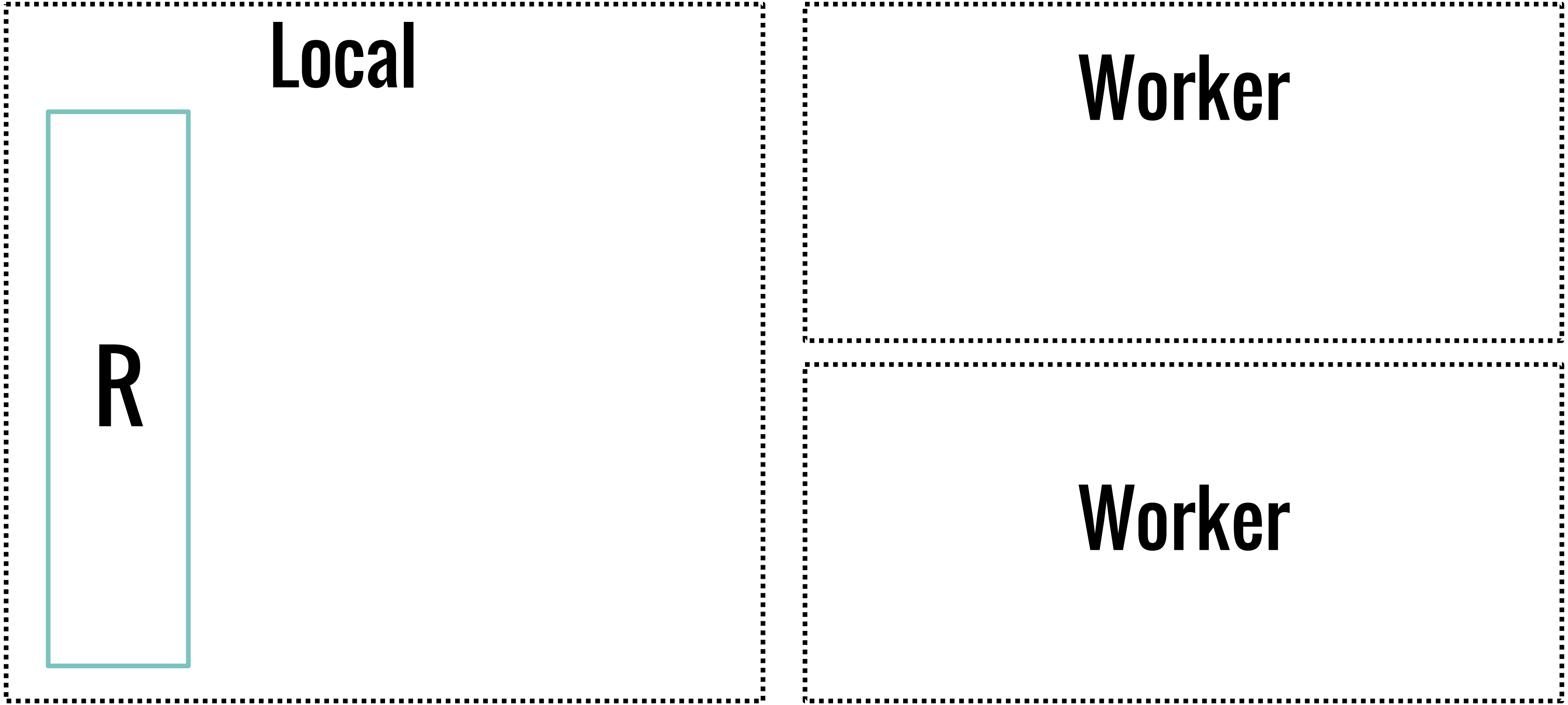


Local

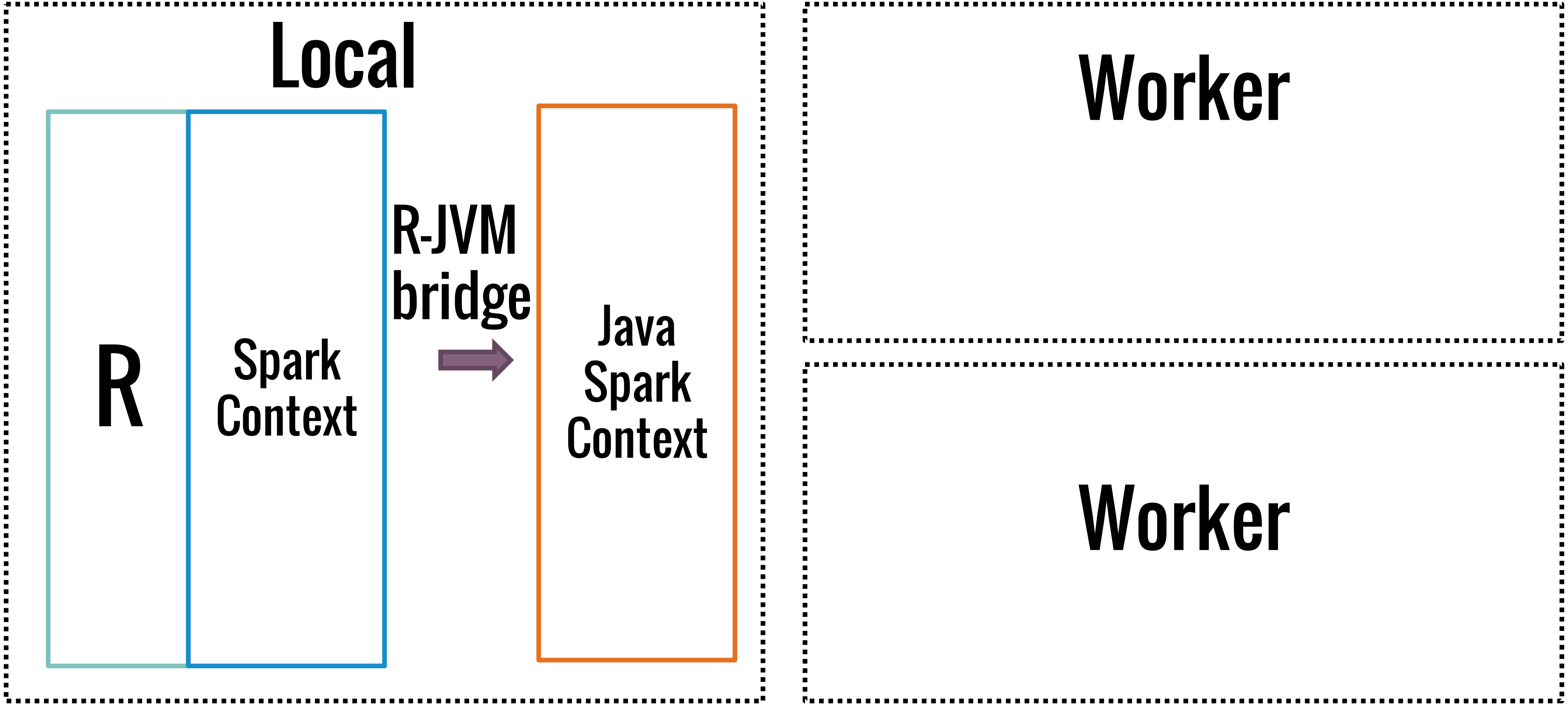
Worker

Worker

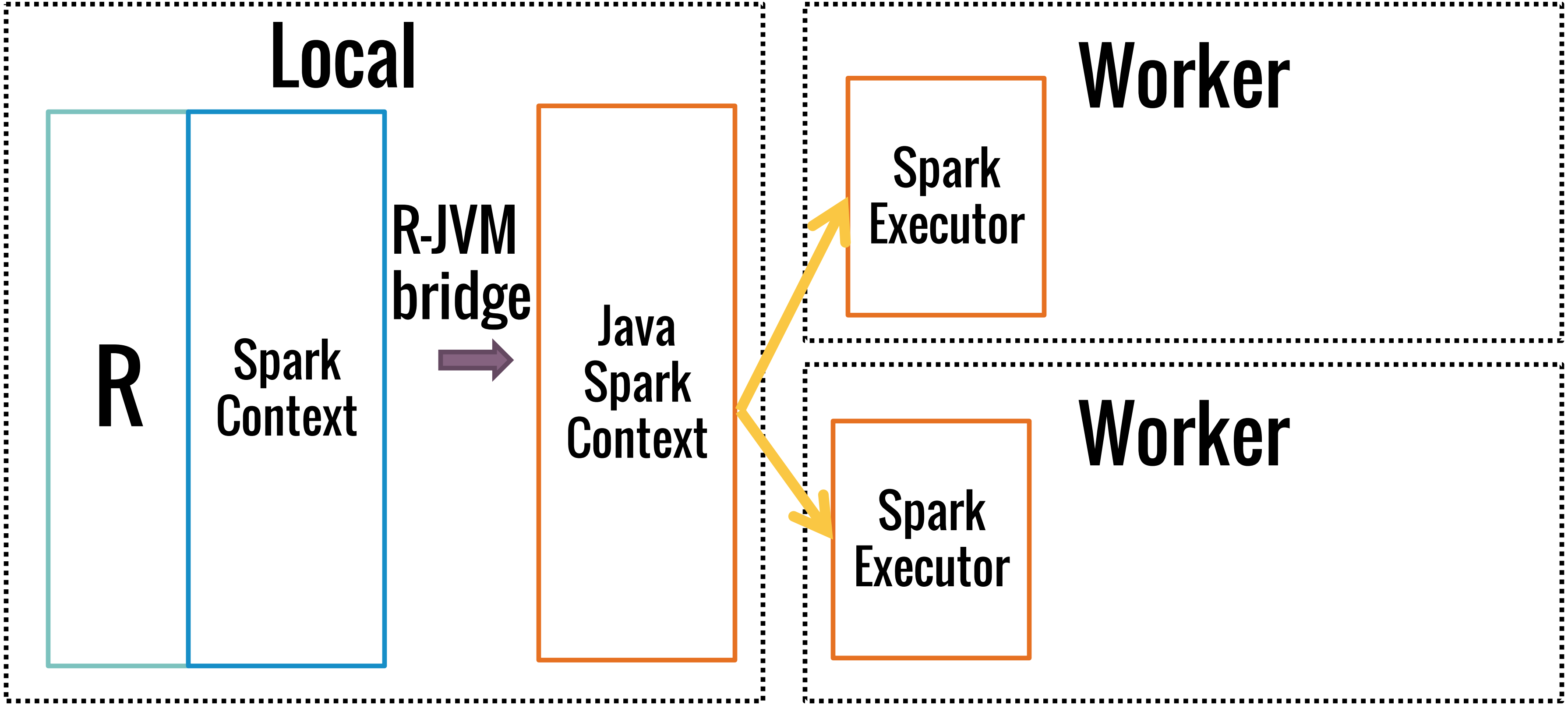
Architecture



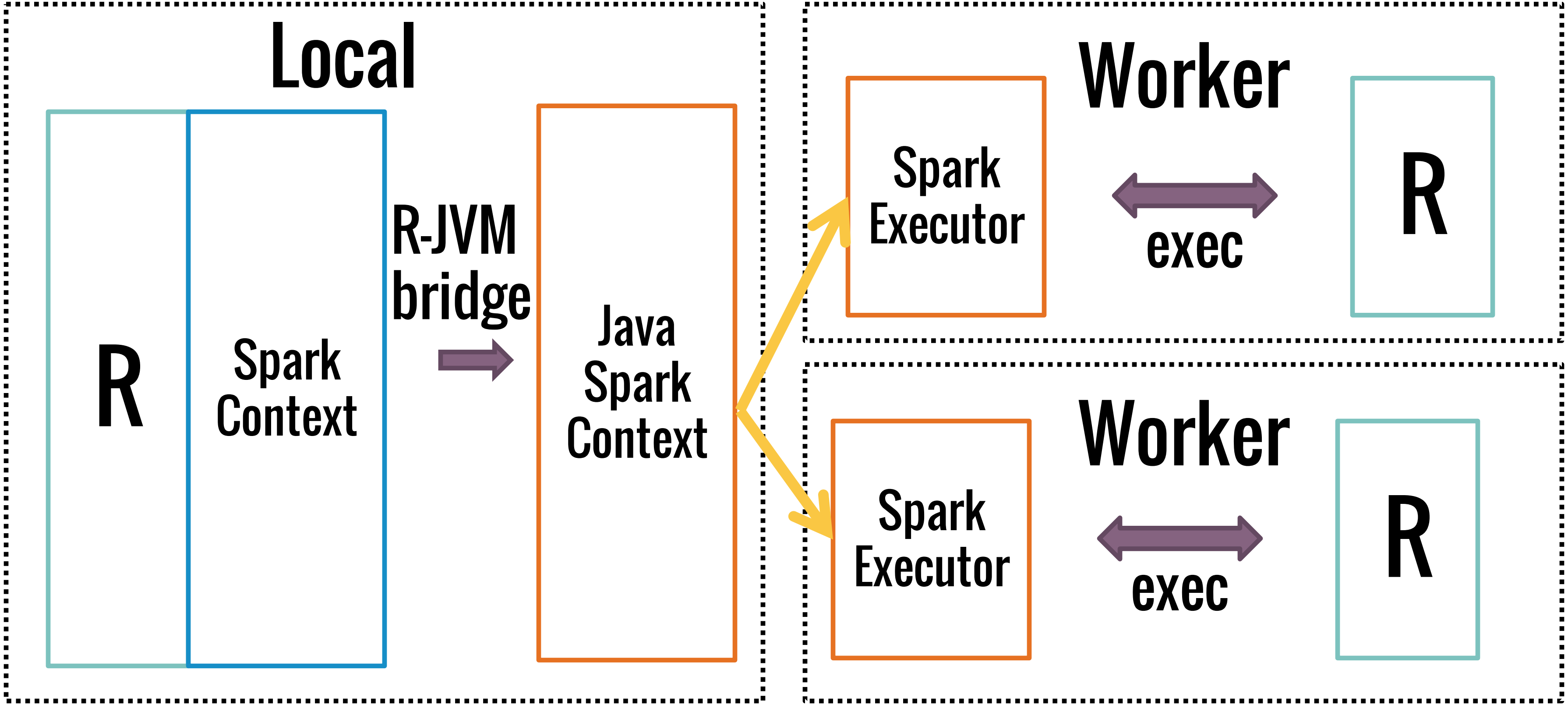
Architecture



Architecture



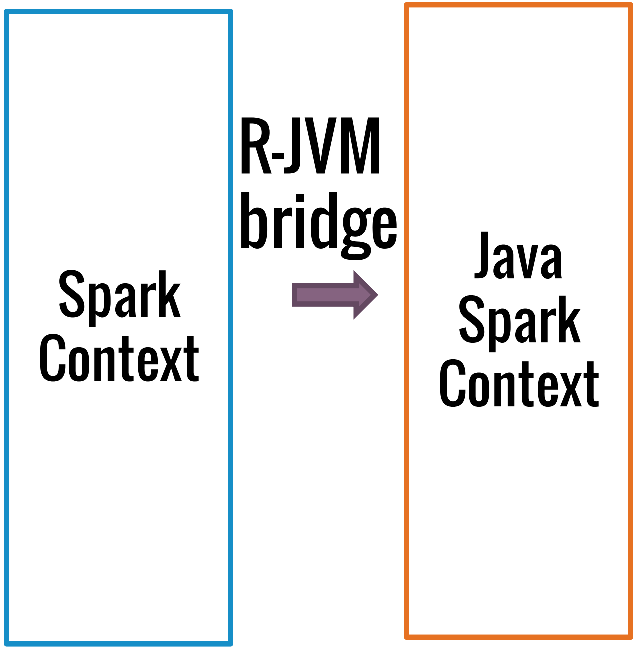
Architecture



Implementation: R-JVM Bridge

Layer to call JVM methods directly from R

Supported across platforms, languages

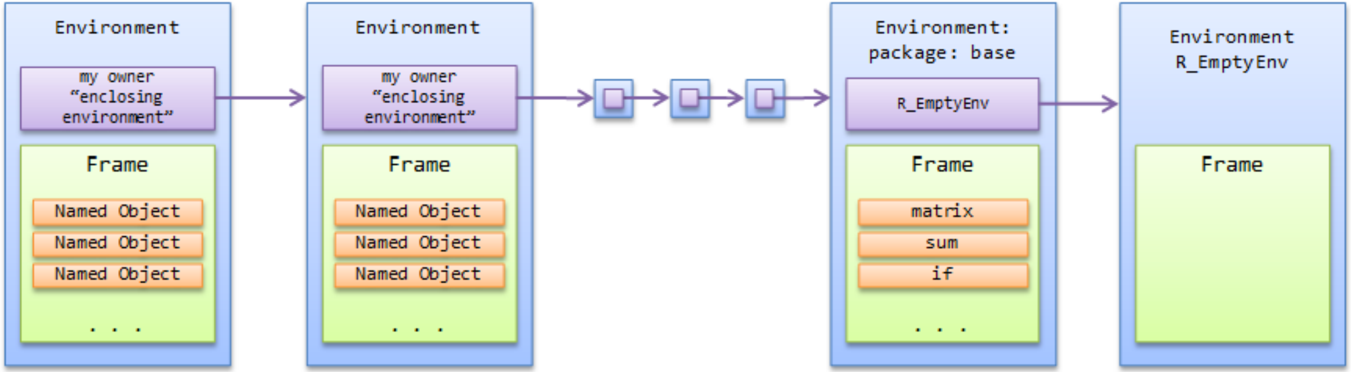


Spark Context

R-JVM bridge

Java Spark Context

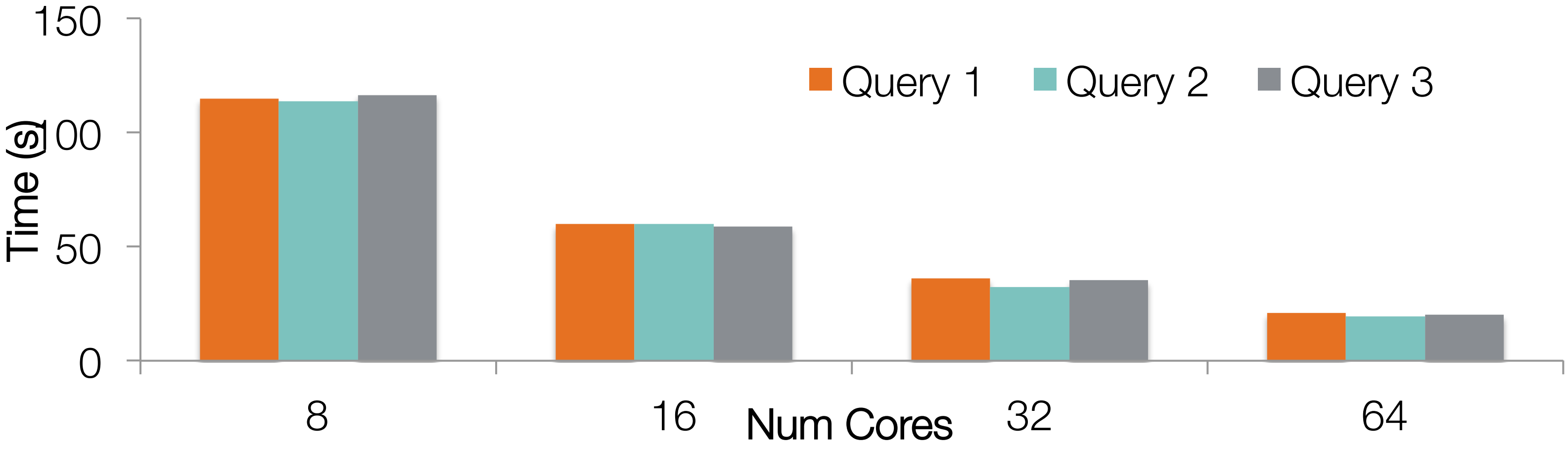
Implementation: Closure Capture



From http://obeautifulcode.com/R/How-R-Searches-And-Finds-Stuff/

Evaluation

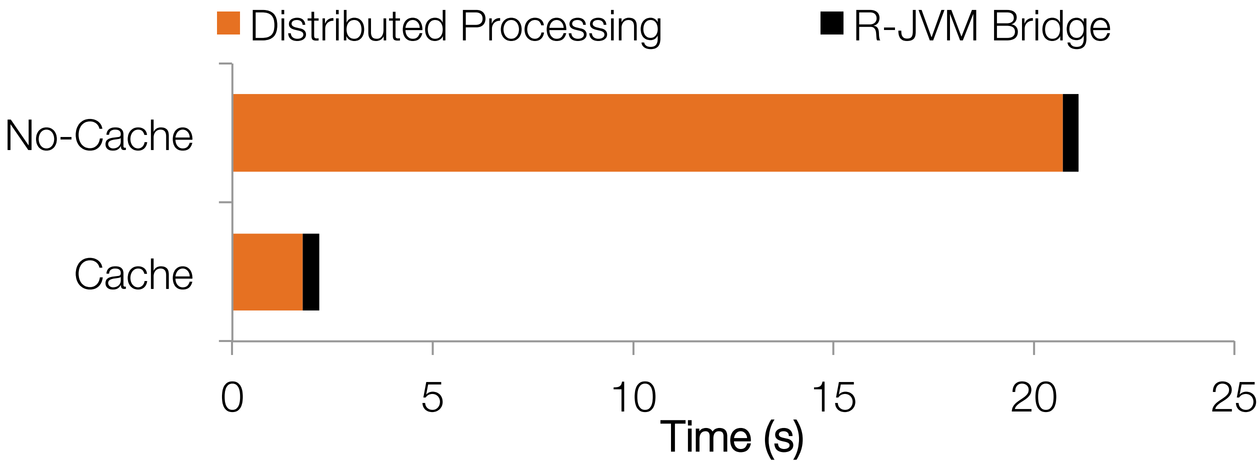
SparkR Scalability



Data: Flight arrivals from 2009-2014, 37.27M rows and 110 columns

Queries: Top-5 destinations, Aggregation, Count-Distinct

R-JVM Bridge



Data: Flight arrivals from 2009-2014, 37.27M rows and 110 columns

Query: Top-5 destinations from JFK on 64 cores

SparkR Status

Open source, part of Apache Spark from 1.4.0

>60 contributors including
UC Berkeley, Databricks, Alteryx, Intel, IBM etc.

SparkR

Big data processing from R

High-level APIs for SQL, ML

Custom R packages with UDFs

Try it out at http://spark.apache.org !