

— *Turning a Zoo into a Circus* —



Data Analytics @ QCRI

FOR PERSONALIZED BIG DATA ANALYTICS

RHEEM is a fast and easy-to-use system for cross-platform big data analytics. It provides an abstraction on top of multiple data processing platforms. It allows users to easily specify their data analytics tasks with easy-to-use declarative language. It gives application developers with opportunities to optimize performance in different ways, and can run on any data processing platform such as PostgreSQL, Spark, or Hadoop MapReduce. RHEEM abstraction is fully based on user-defined functions (UDFs) to allow users to focus on their applications logics rather than on physical details. Users can quickly develop and deploy their big data analytic tasks on a matter of a couple of days. The salient features of RHEEM include multi-platform task execution, high performance, flexibility, and ease-of-use.

Multi-Platform Task Execution

San Francisco, USA (demo paper)

[RHEEM-website/about.html#](#)

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Nan Tang

Collaborators

Divy Agrawal

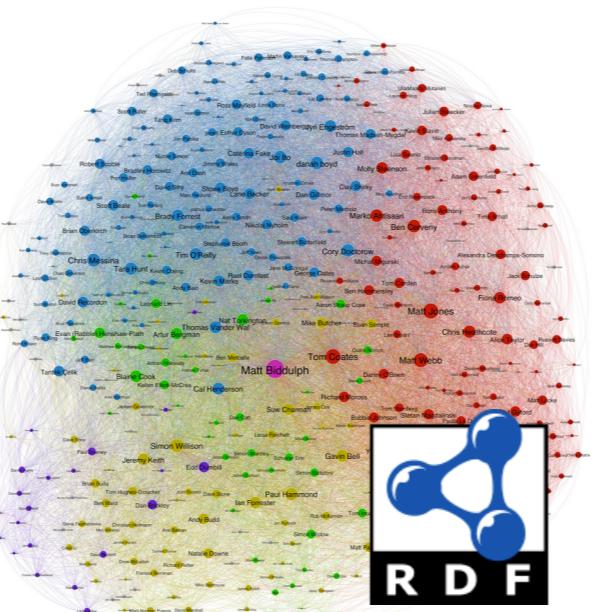
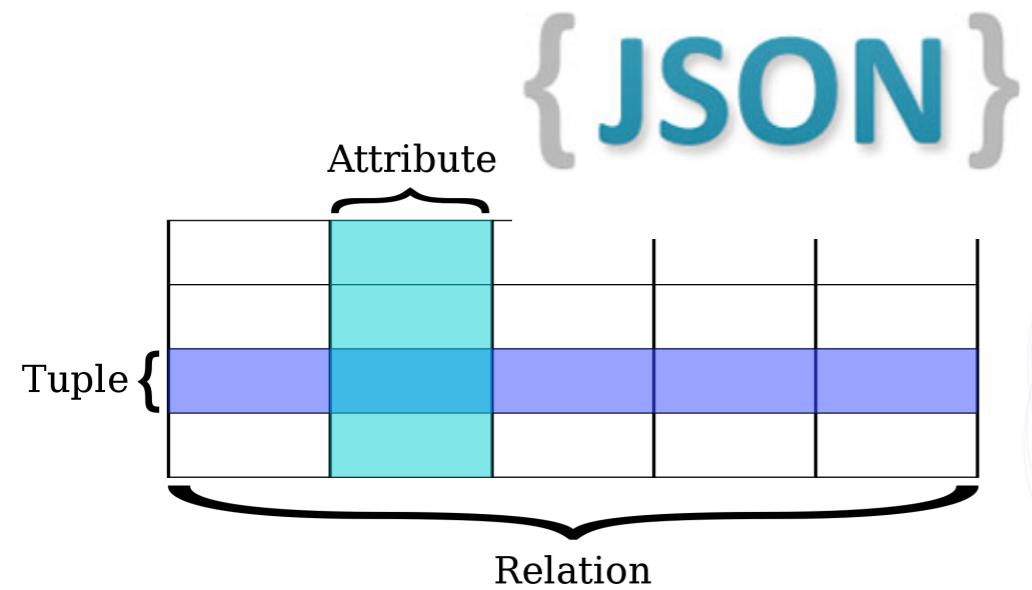
Paolo Papotti

Mohammed Zaki



Big Data (3Vs)

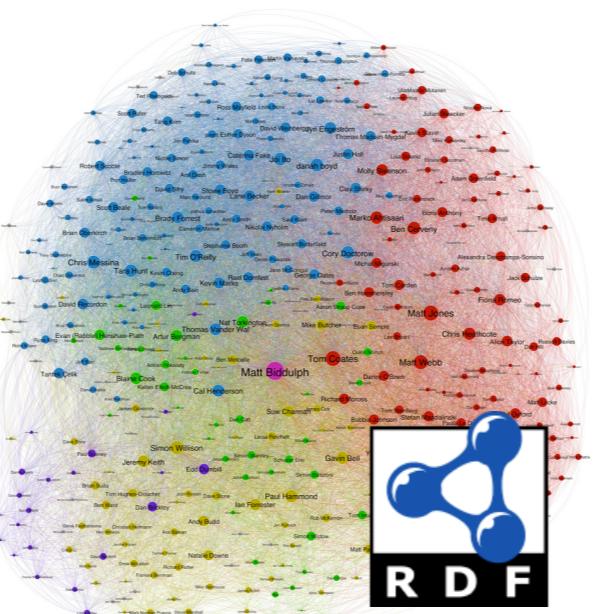
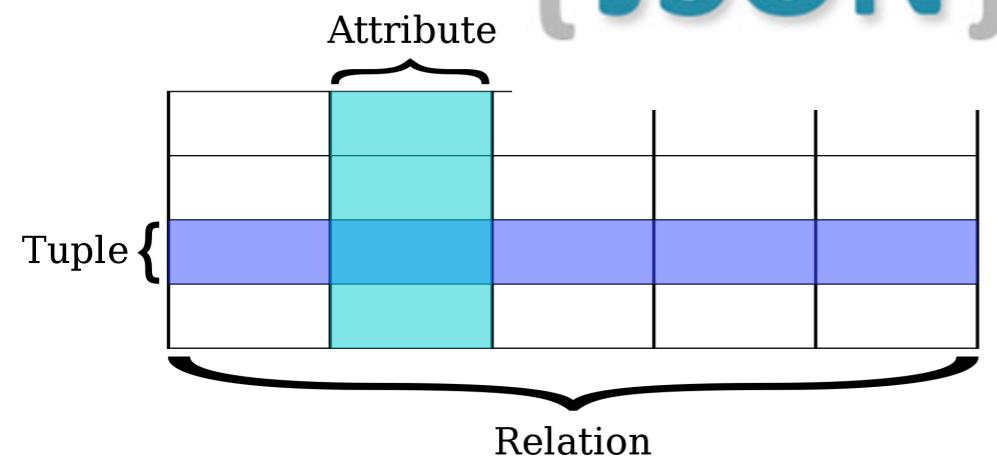
Big Data (1V: Variety)



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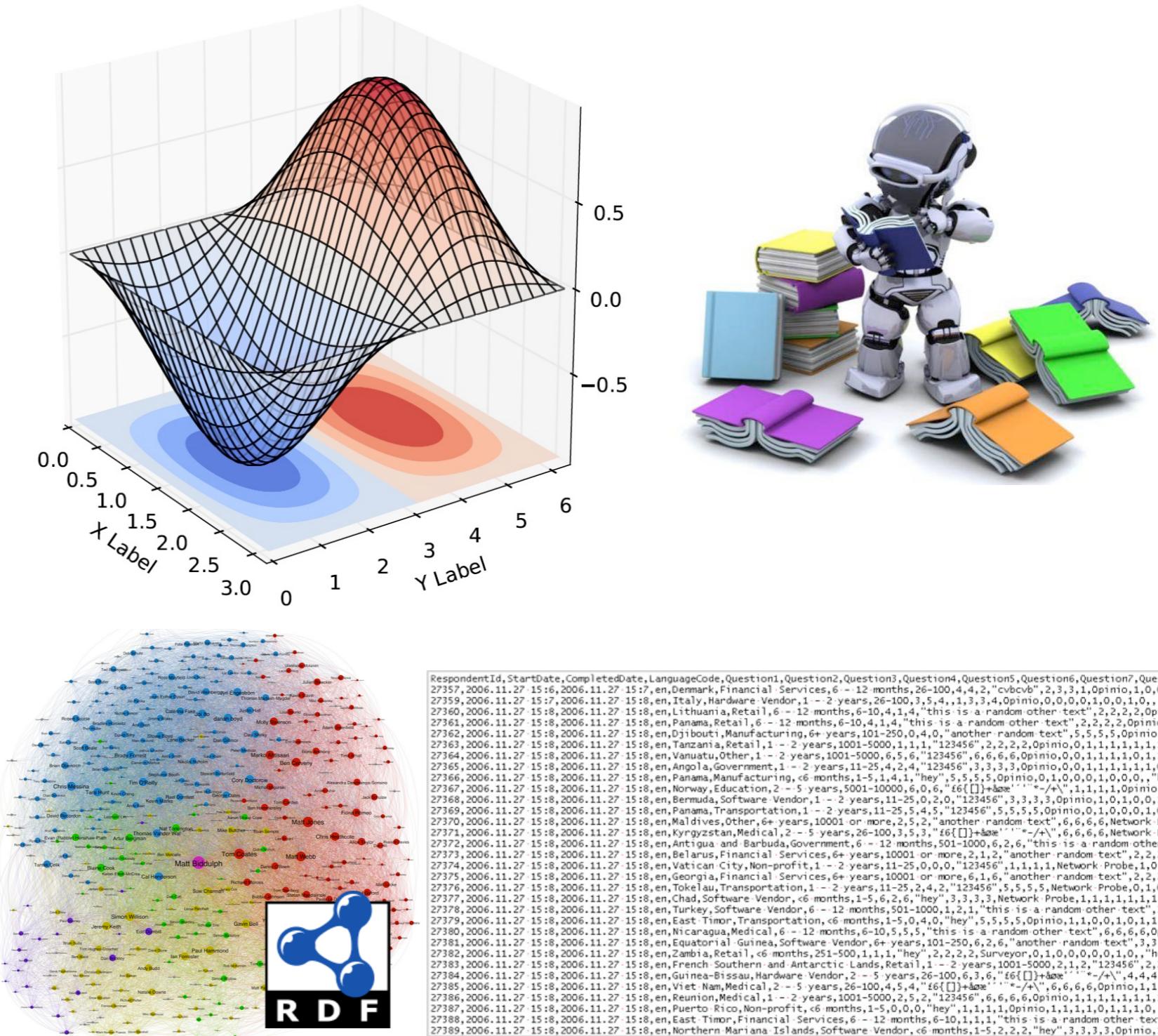
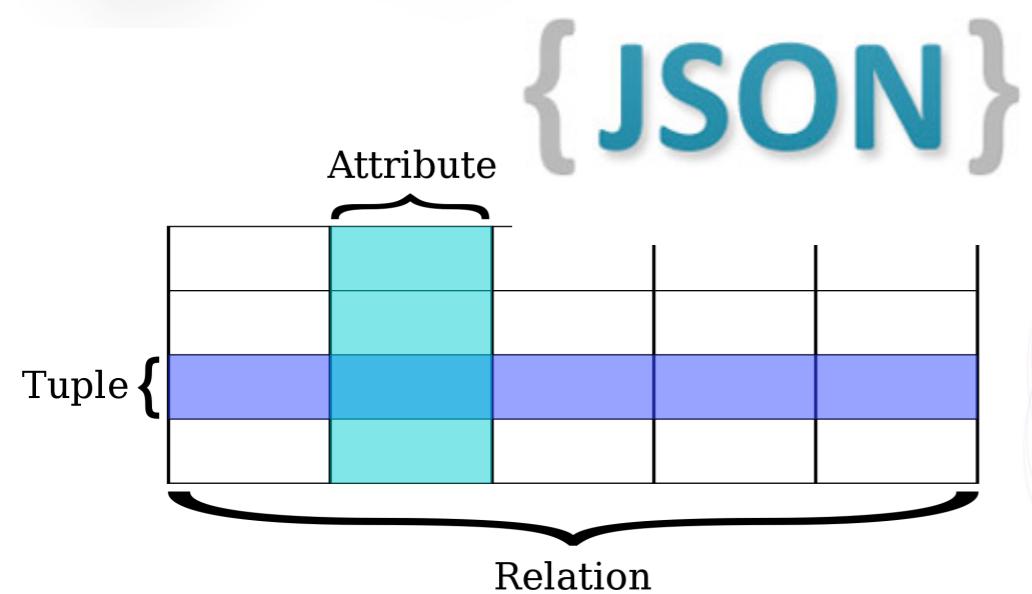
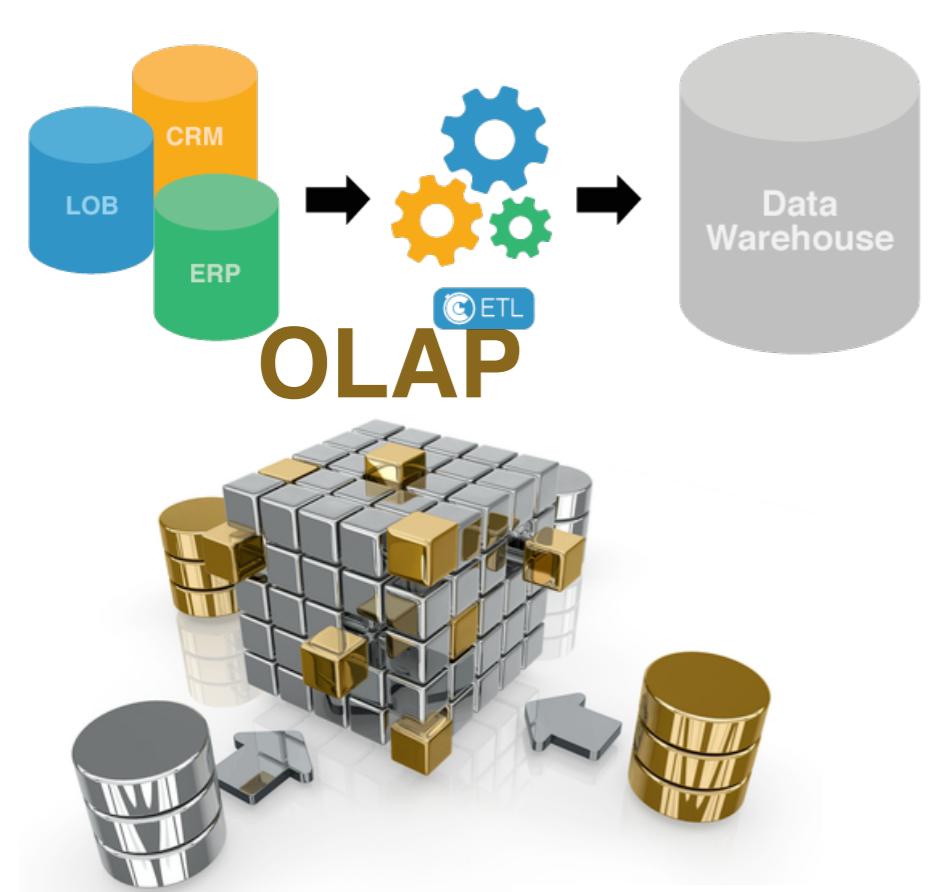


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Big Data (1V: Variety)

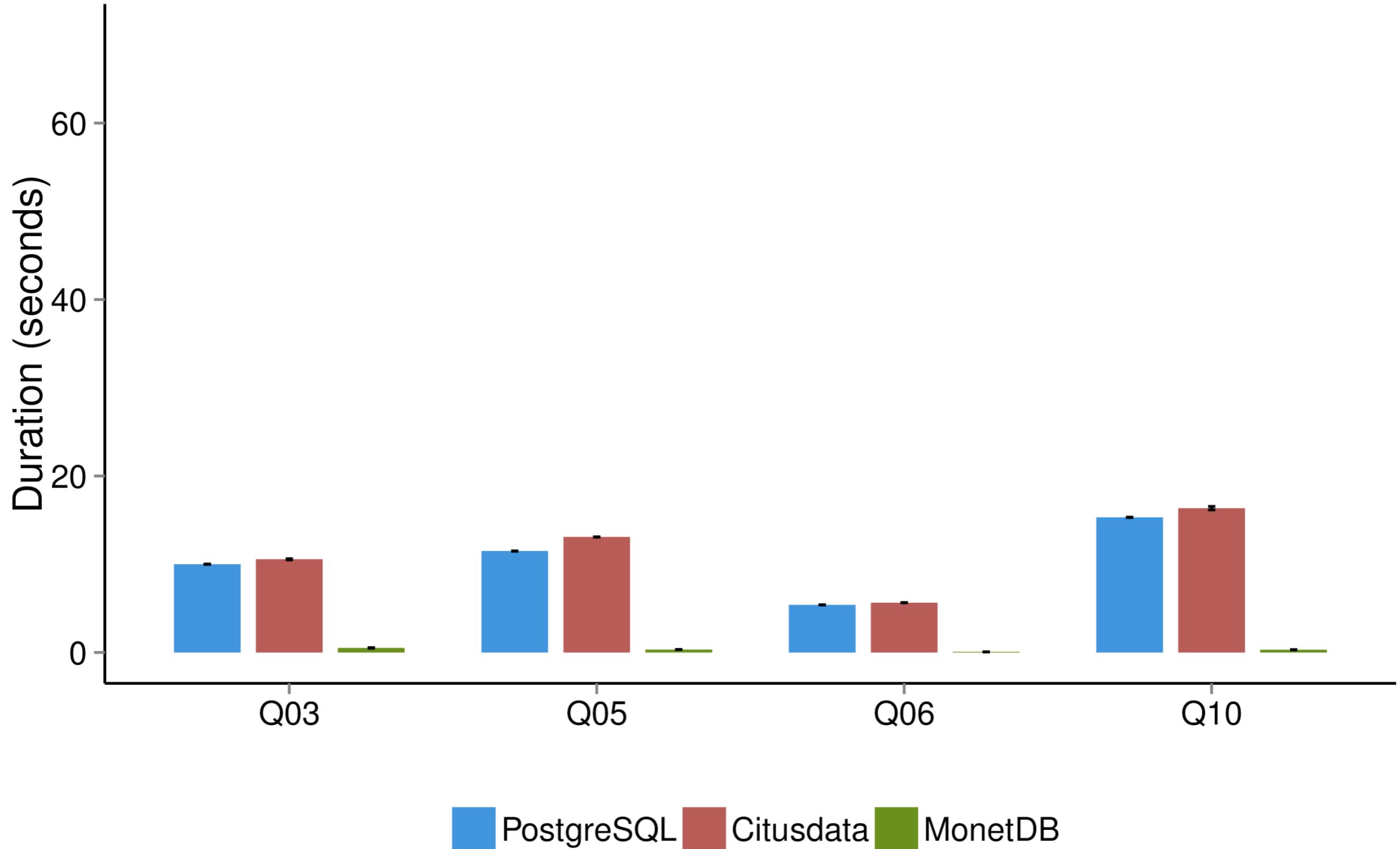


Big Data (1V: Variety)

One Size
Does Not Fit All

Query Speed (Hot)

TPC-H SF5 (5.2 GB)

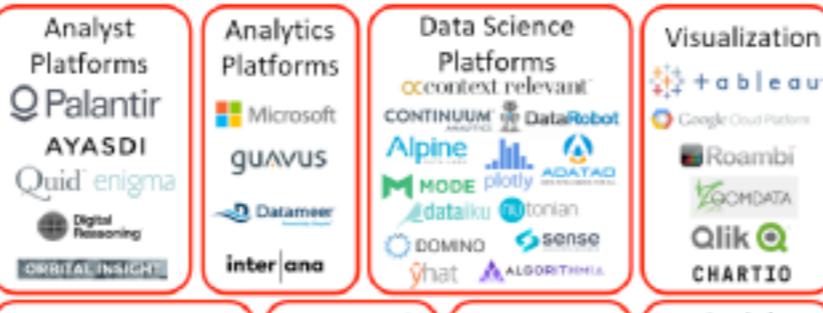


Big Data Landscape 2016

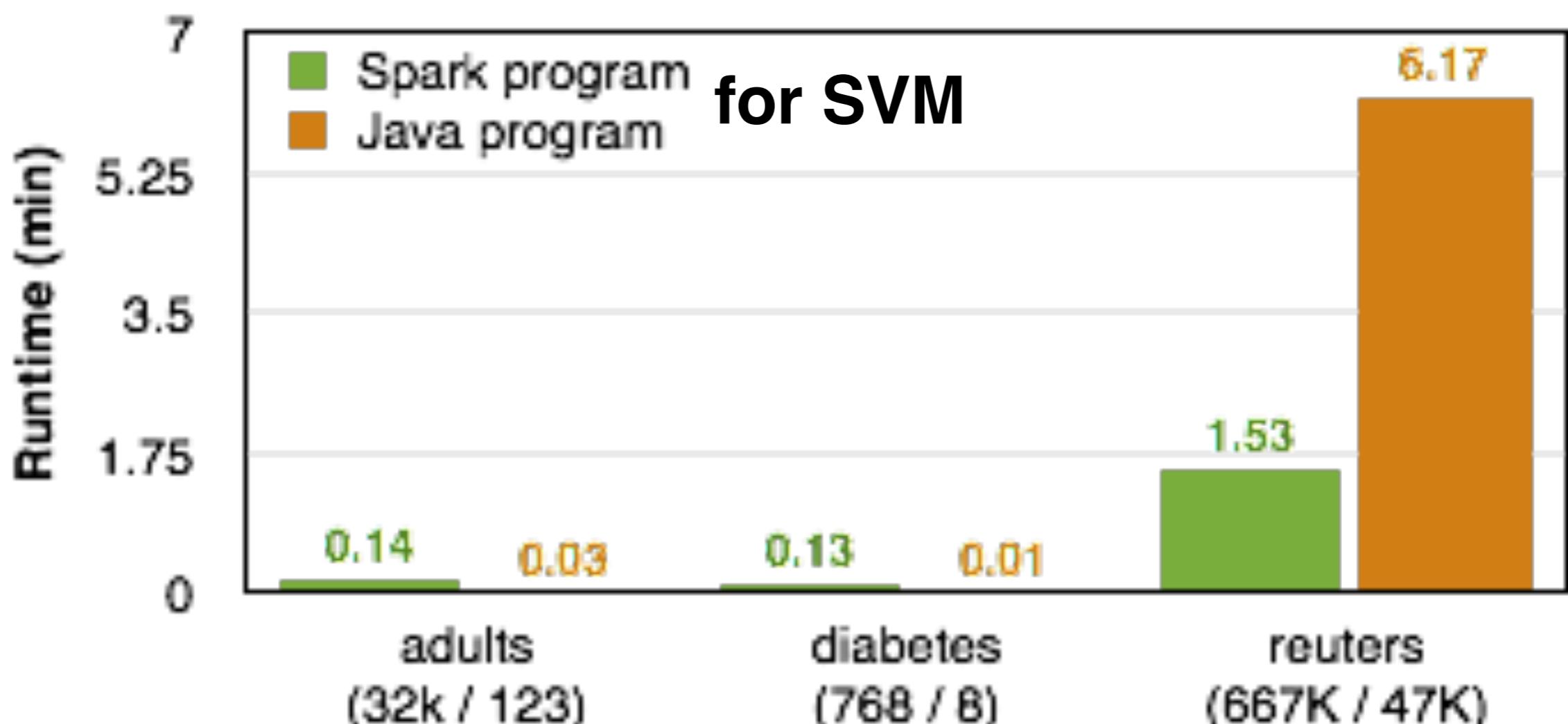
Infrastructure



Analytics



Applications



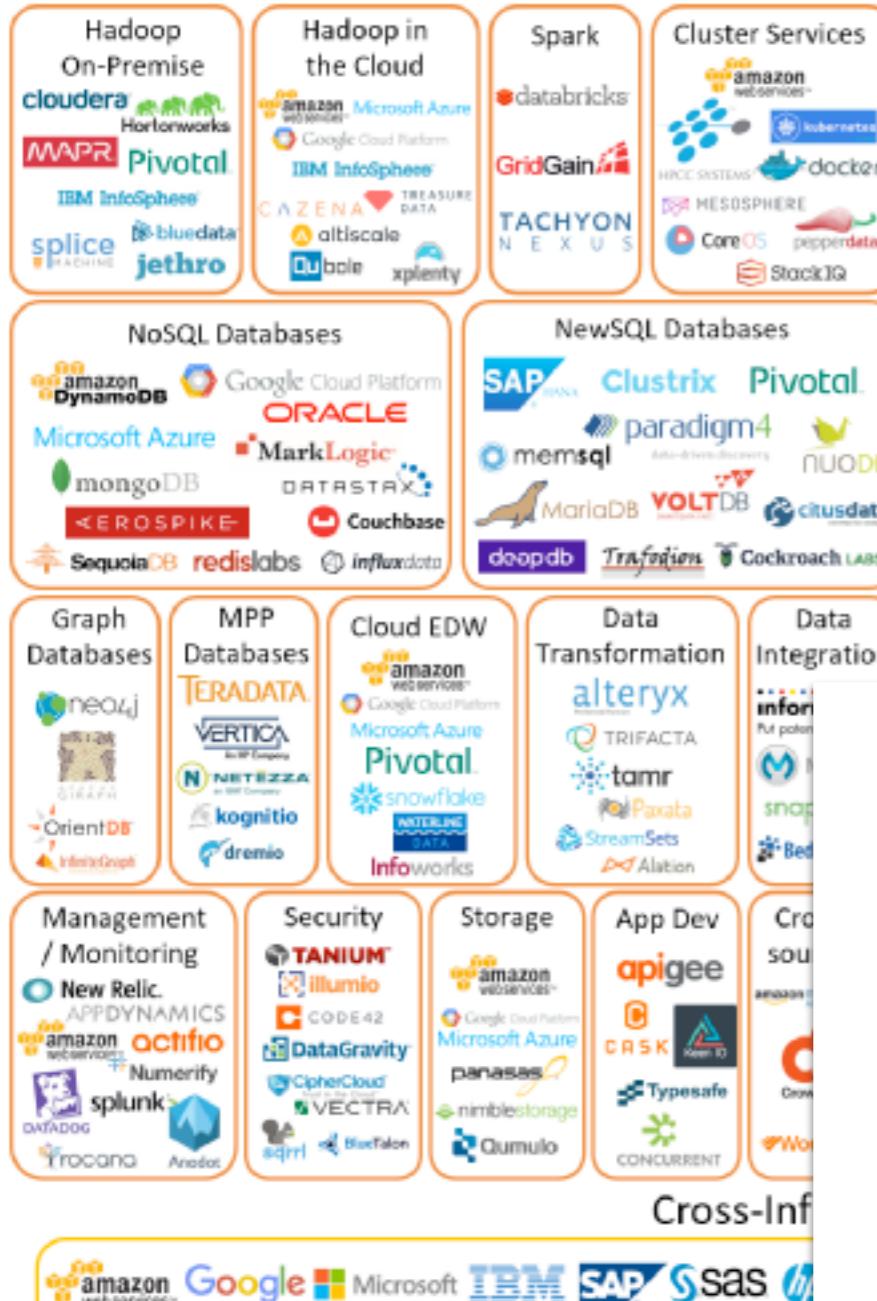
Data Sources & APIs

Incubators & Schools



Big Data Landscape 2016

Infrastructure



Analytics



Applications



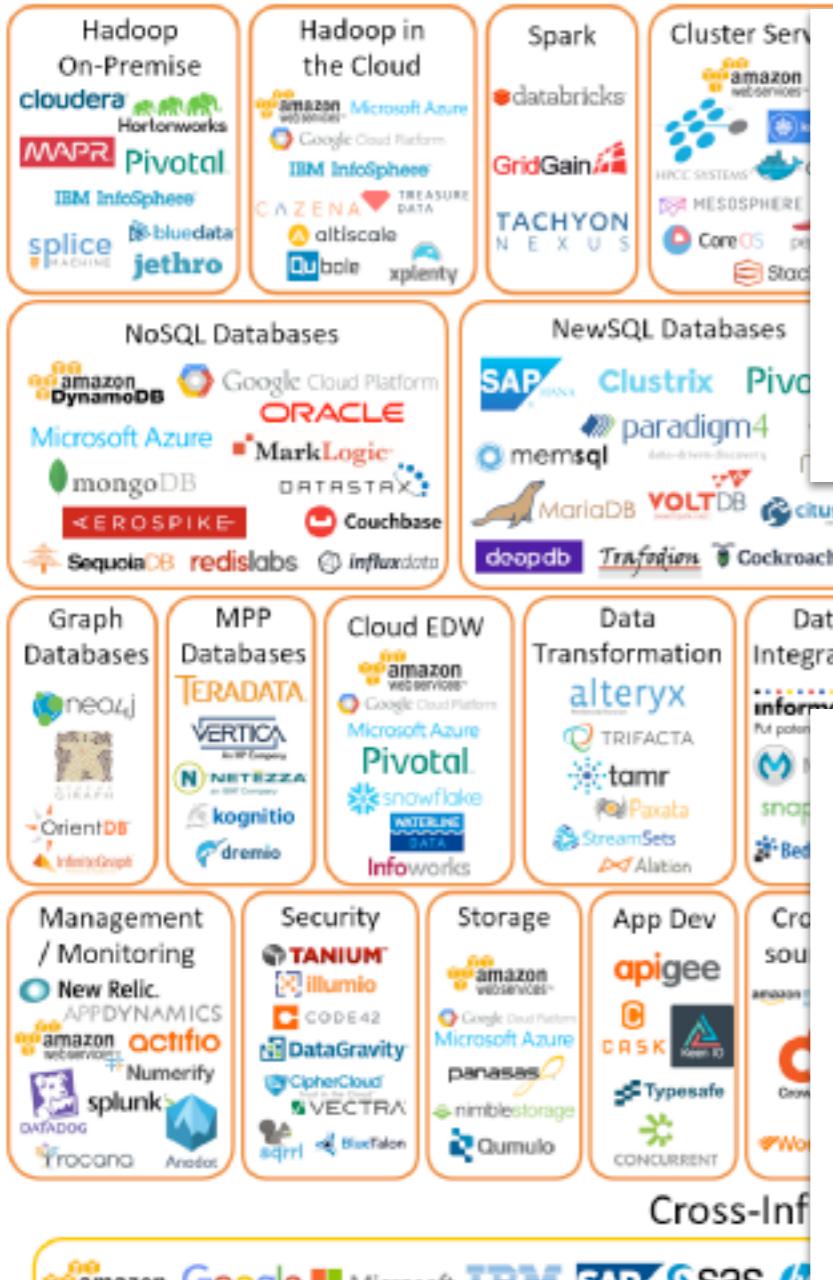
PostgreSQL

Data Sources & References

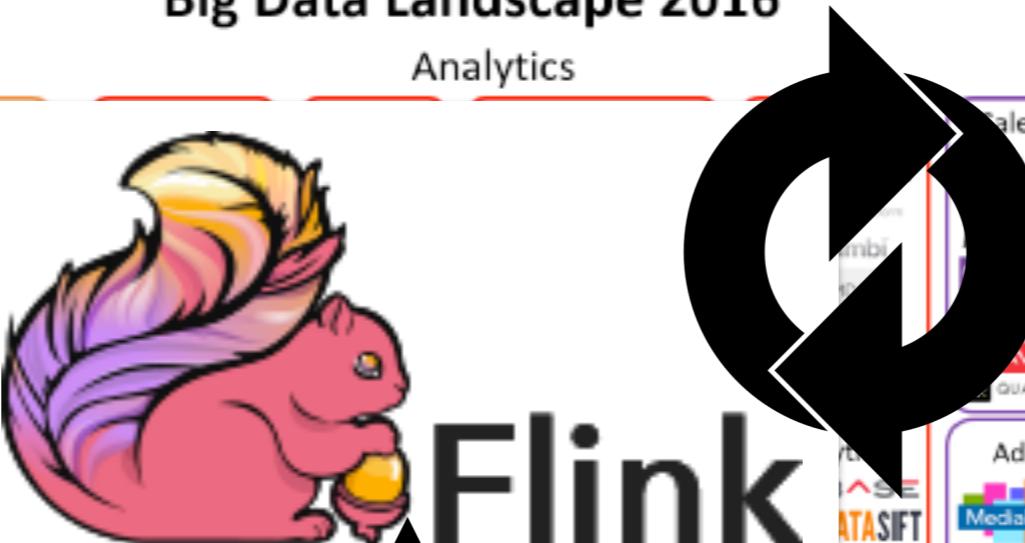


Big Data Landscape 2016

Infrastructure



Analytics



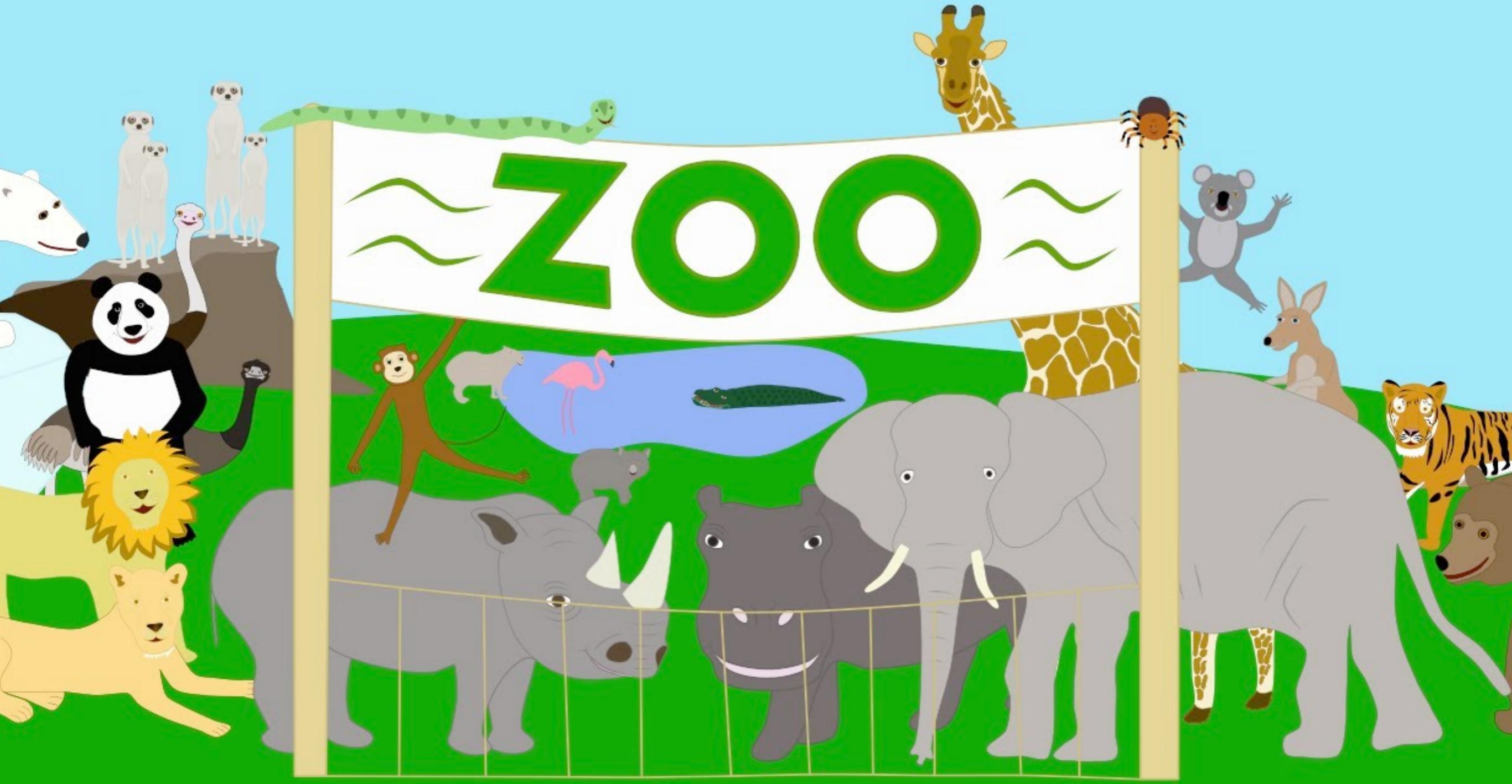
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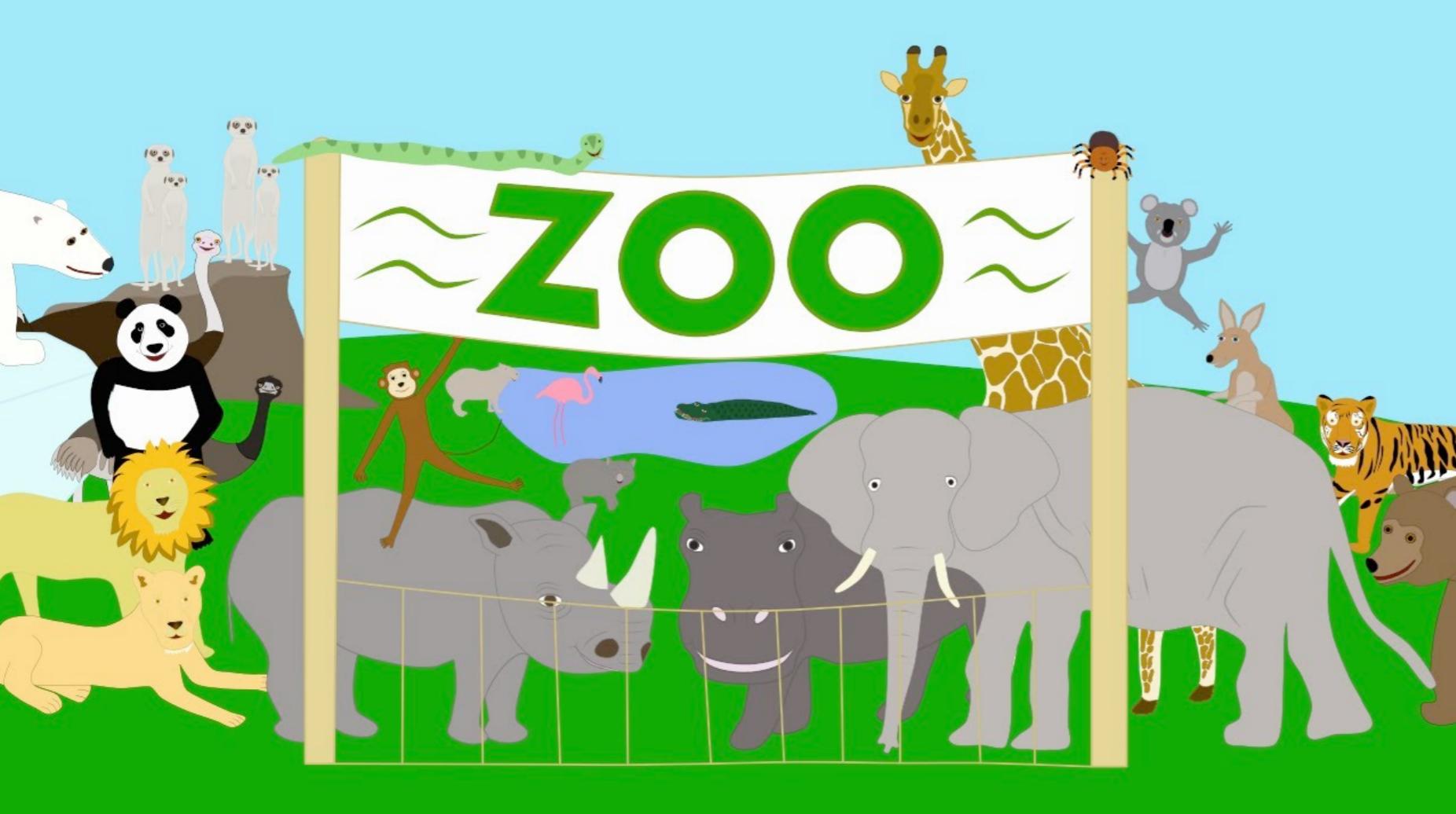
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Data Sources & APIs





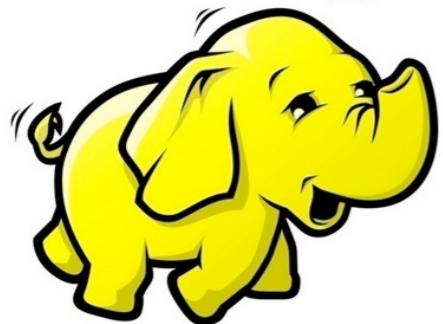
How to Deploy Apps?



A System Tamer



hadoop

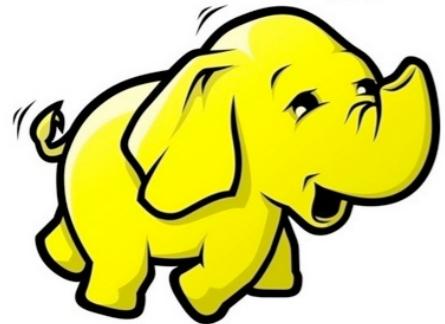


PostgreSQL

GraphLab



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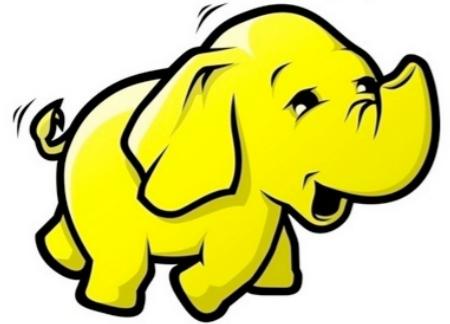


PostgreSQL

GraphLab

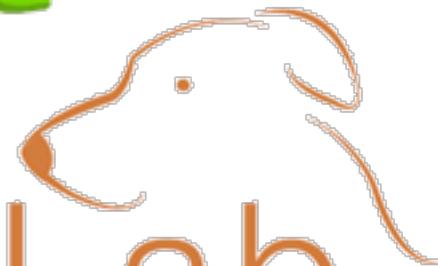


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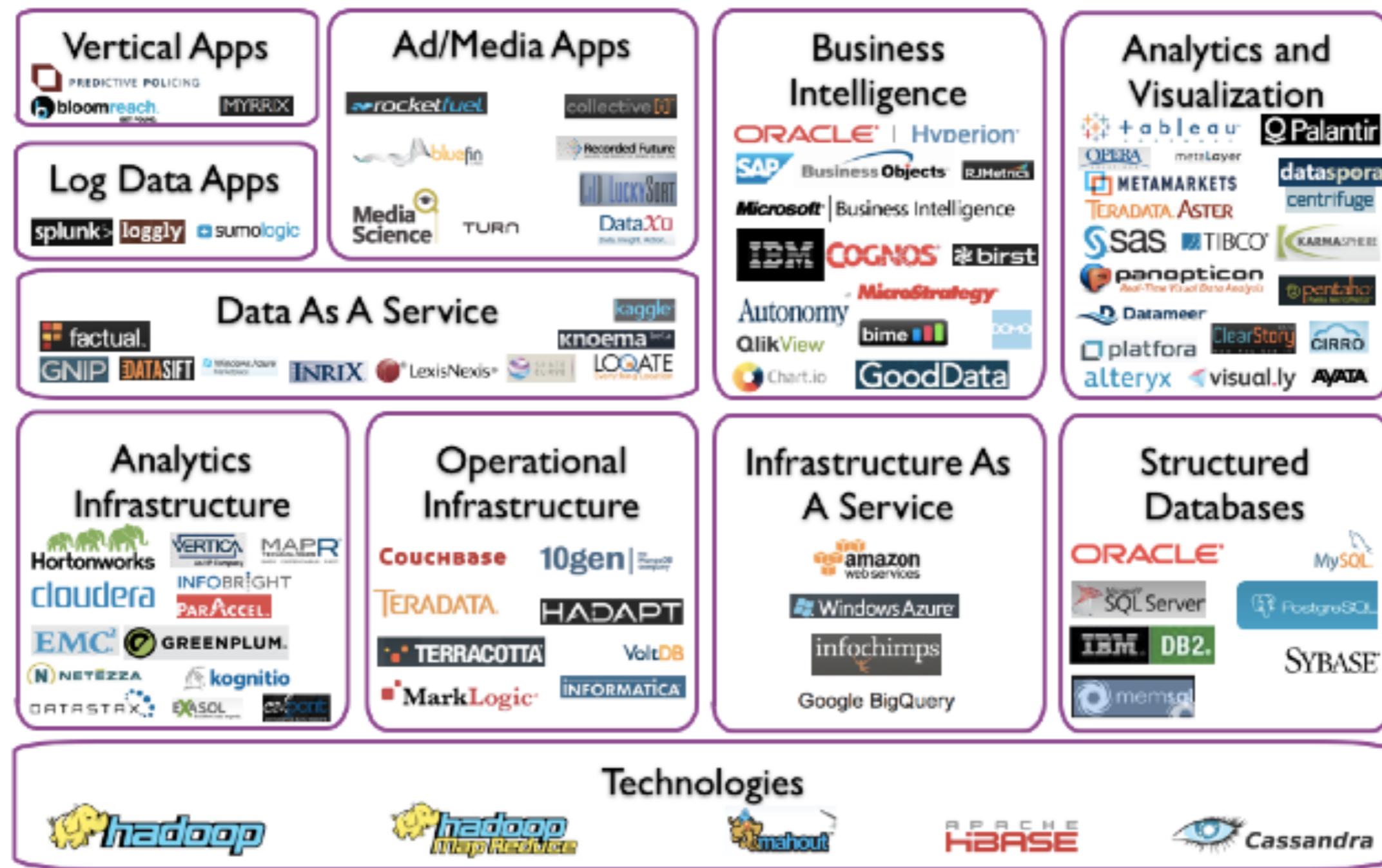


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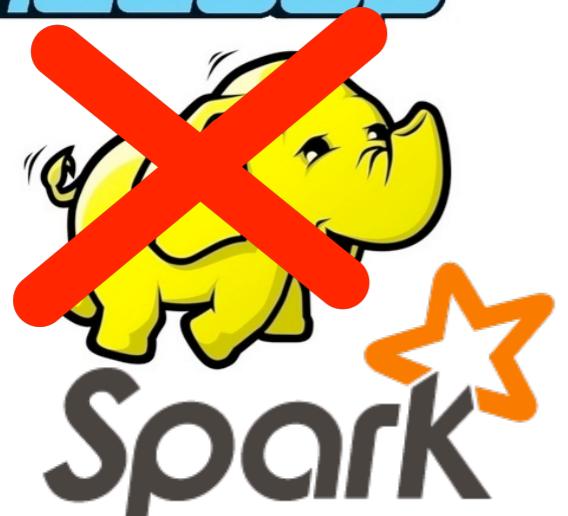


Big Data Landscape in 2014

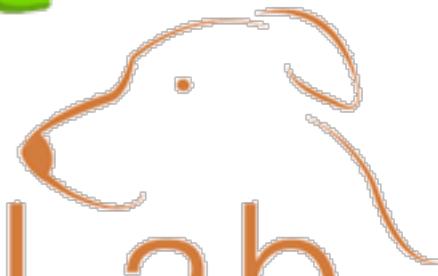




hadoop



Luigi

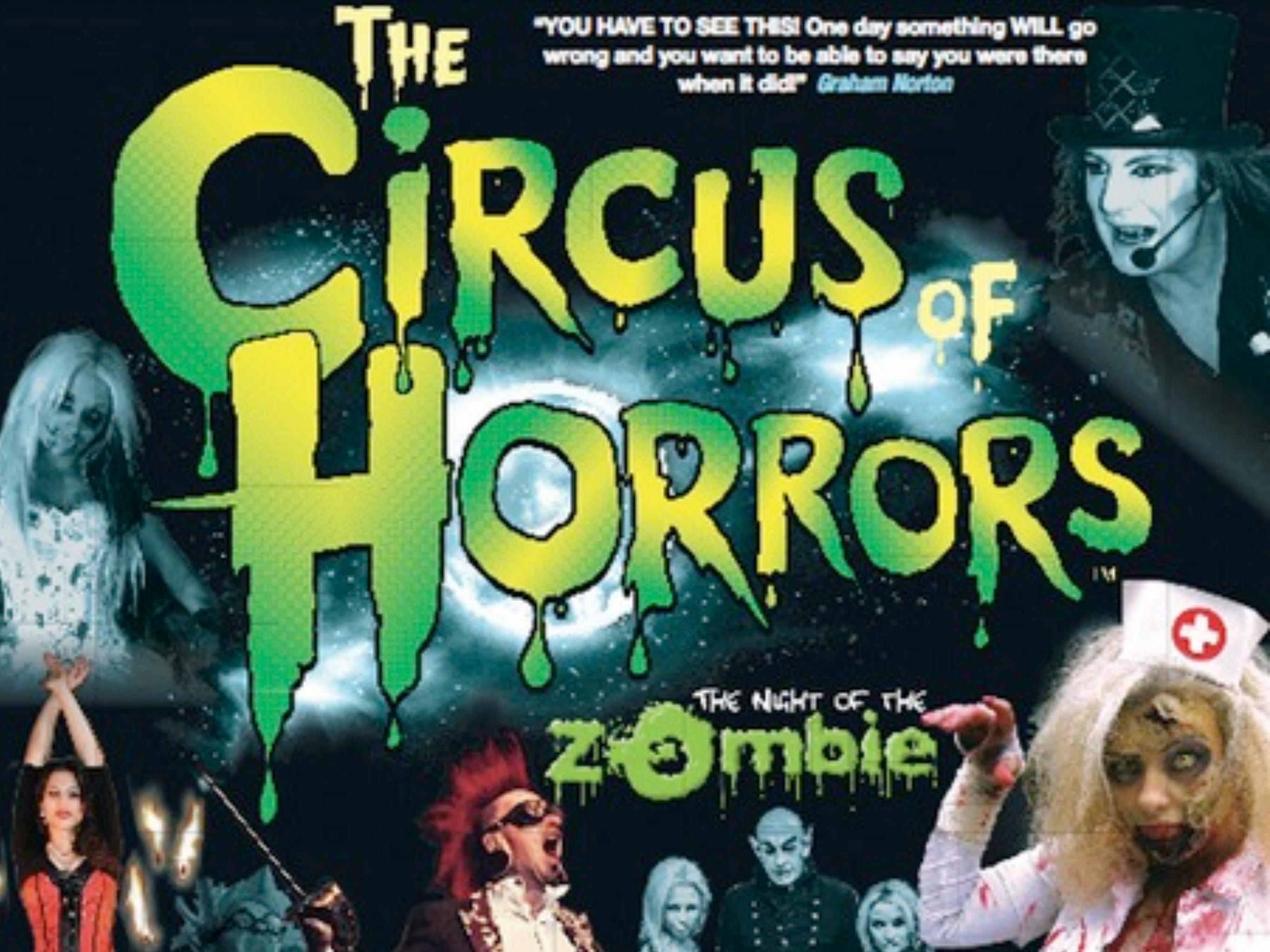


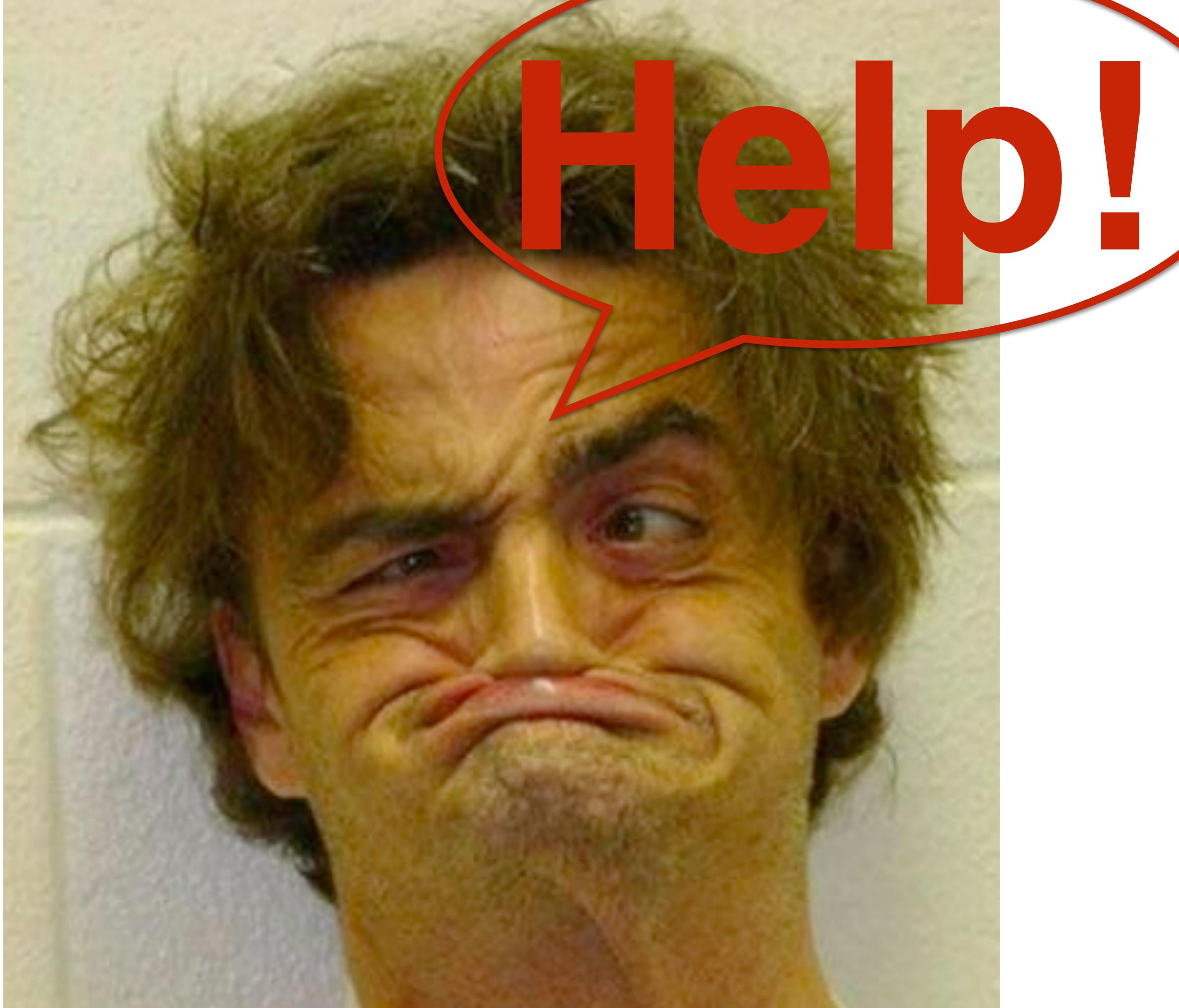
GraphLab

THE CIRCUS OF HORRORS

"YOU HAVE TO SEE THIS! One day something WILL go wrong and you want to be able to say you were there when it did!" Graham Norton

TM
THE NIGHT OF THE
Zombie





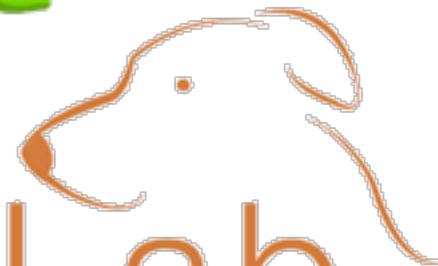
Help!



hadoop



GraphLab





An Automatic System Tamer

Problems

- System dependent
- Need for many systems
- Requires high expertise
- Performance sacrifice

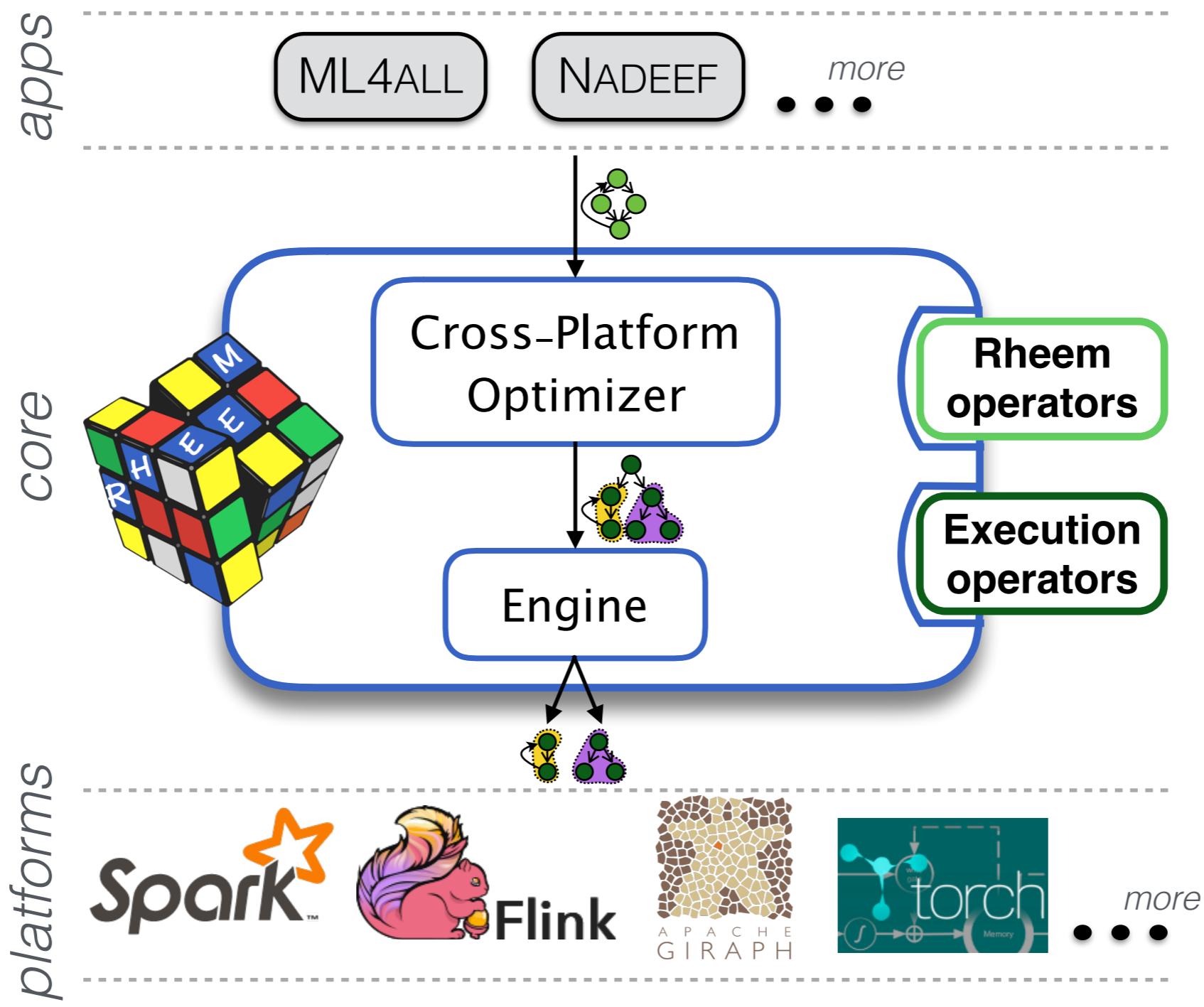
Problems

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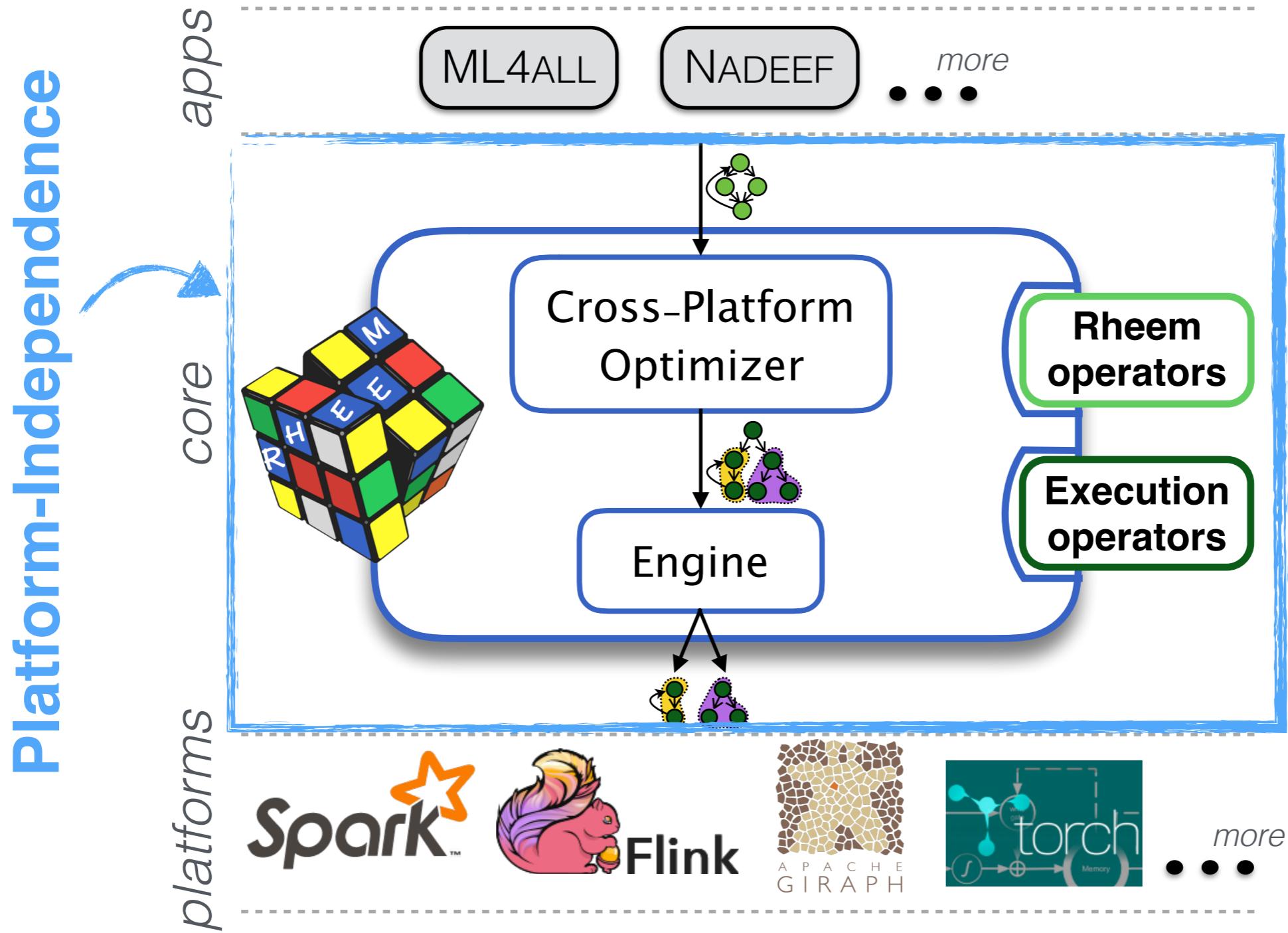


RHEEM

- Platform-independence
- Cross-platform execution
- Ease-of-use
- High-performance

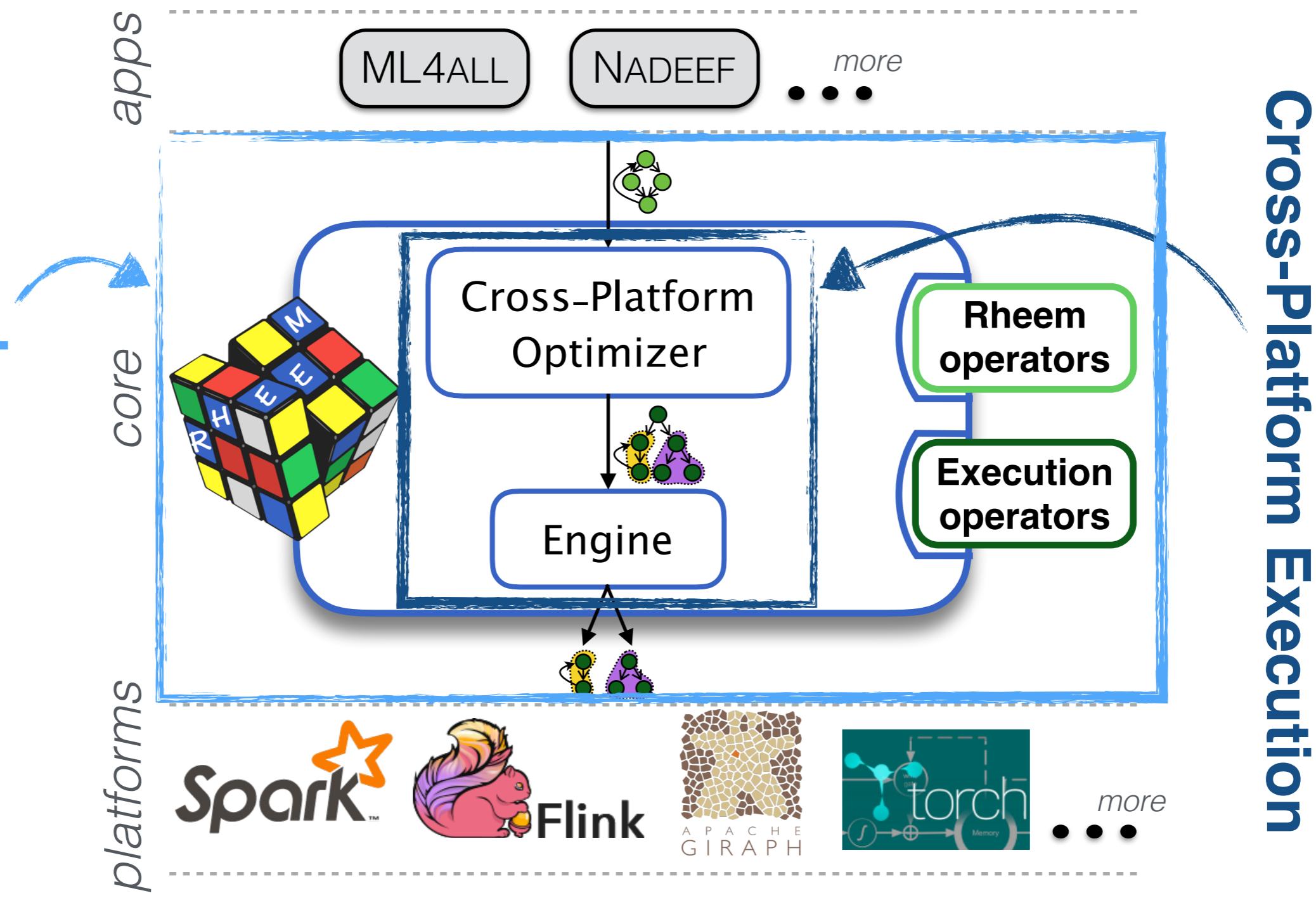


RHEEM



RHEEM

Platform-Independence

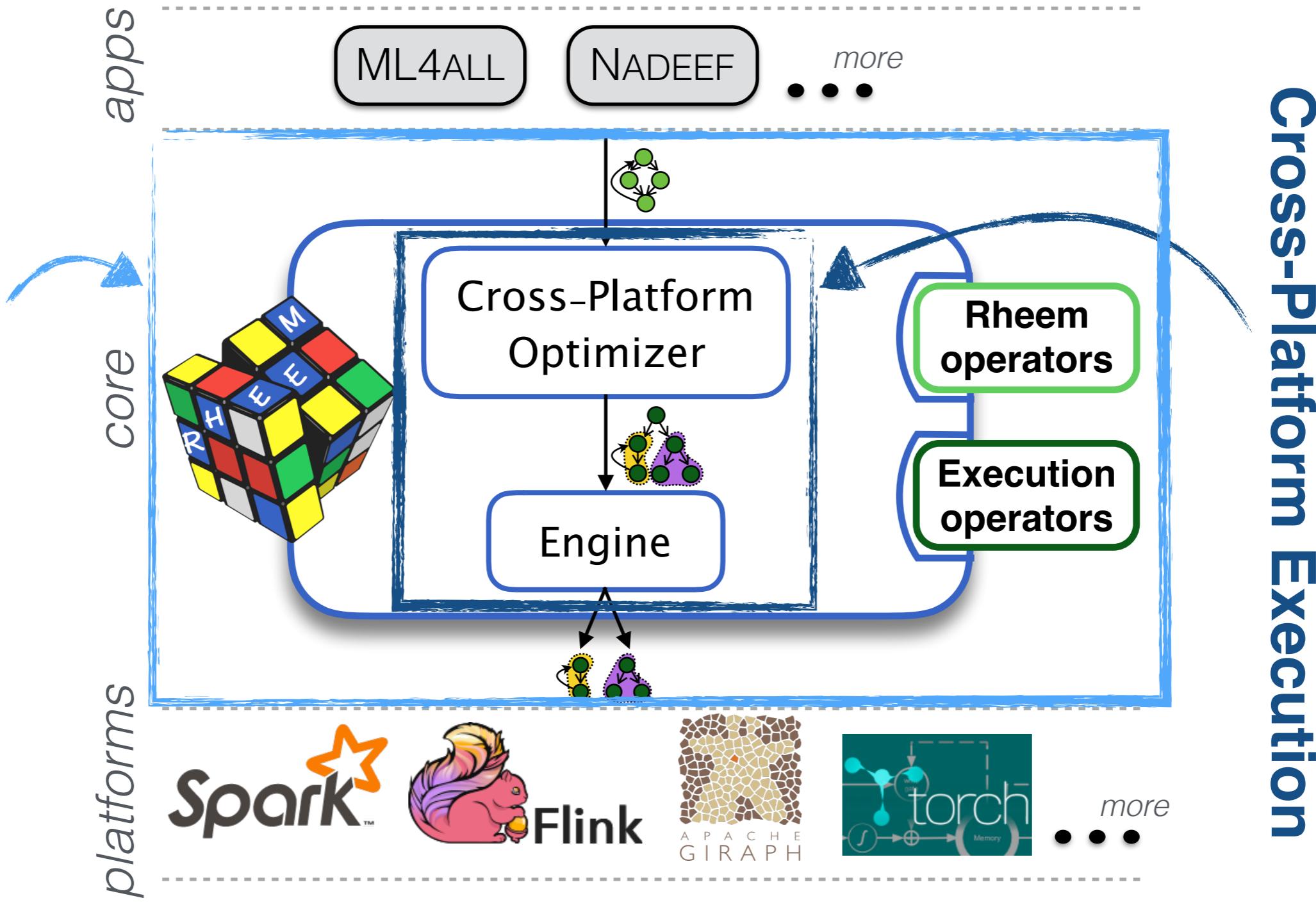


RHEEM

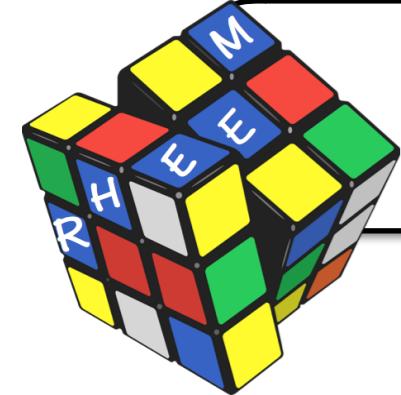
Cross-Platform Execution

Agenda

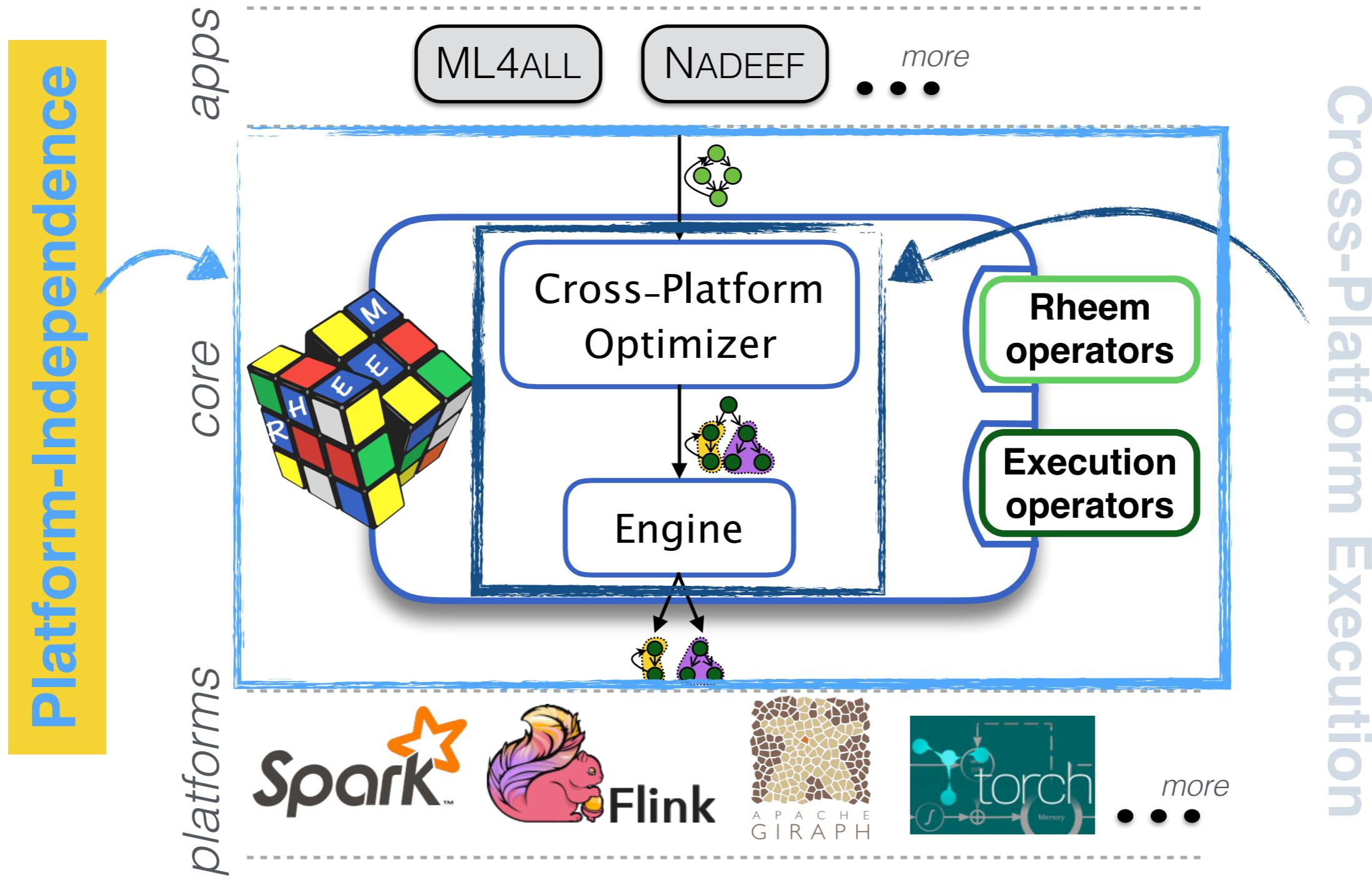
Platform-Independence

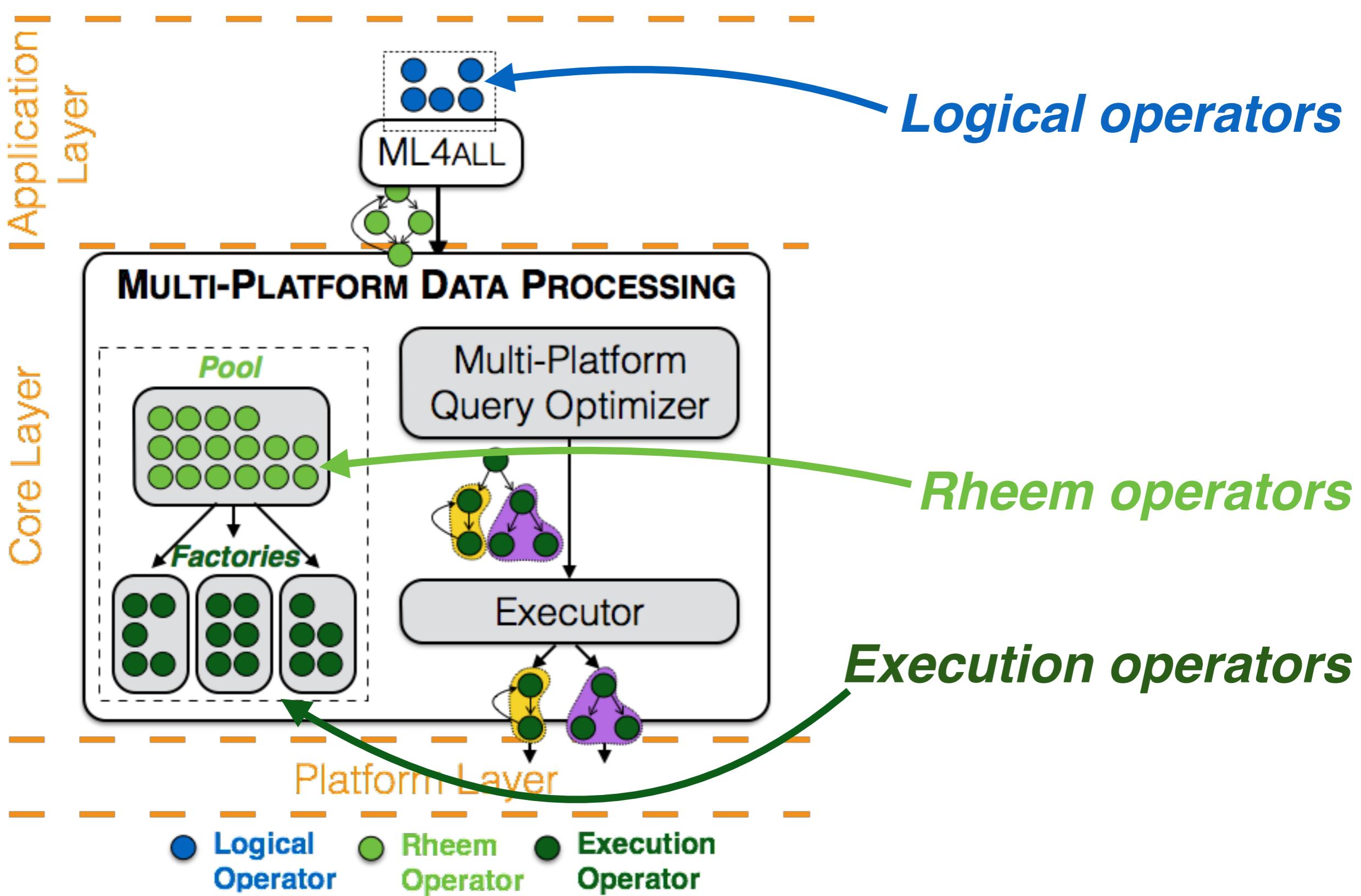


Cross-Platform Execution

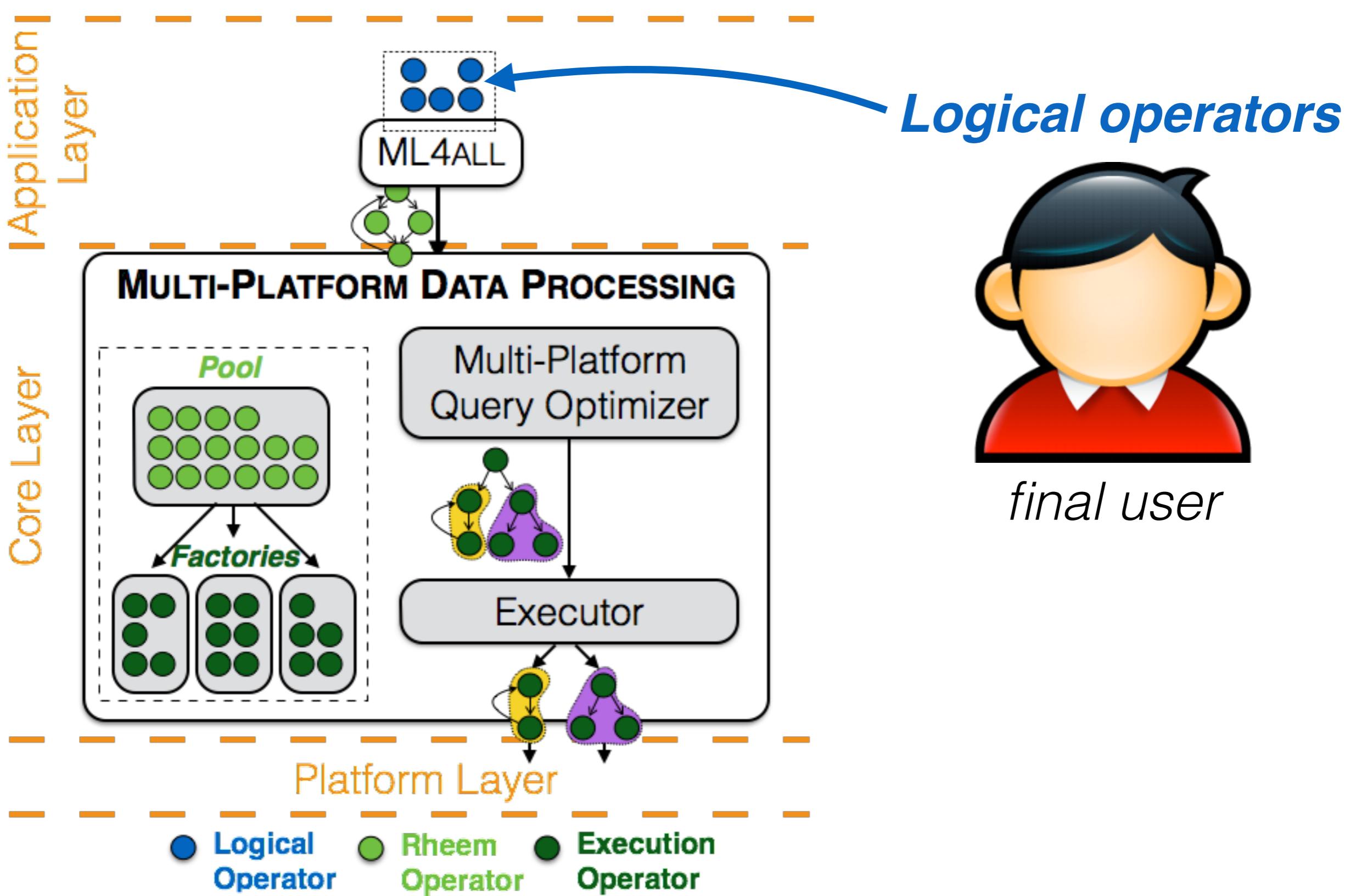


Agenda

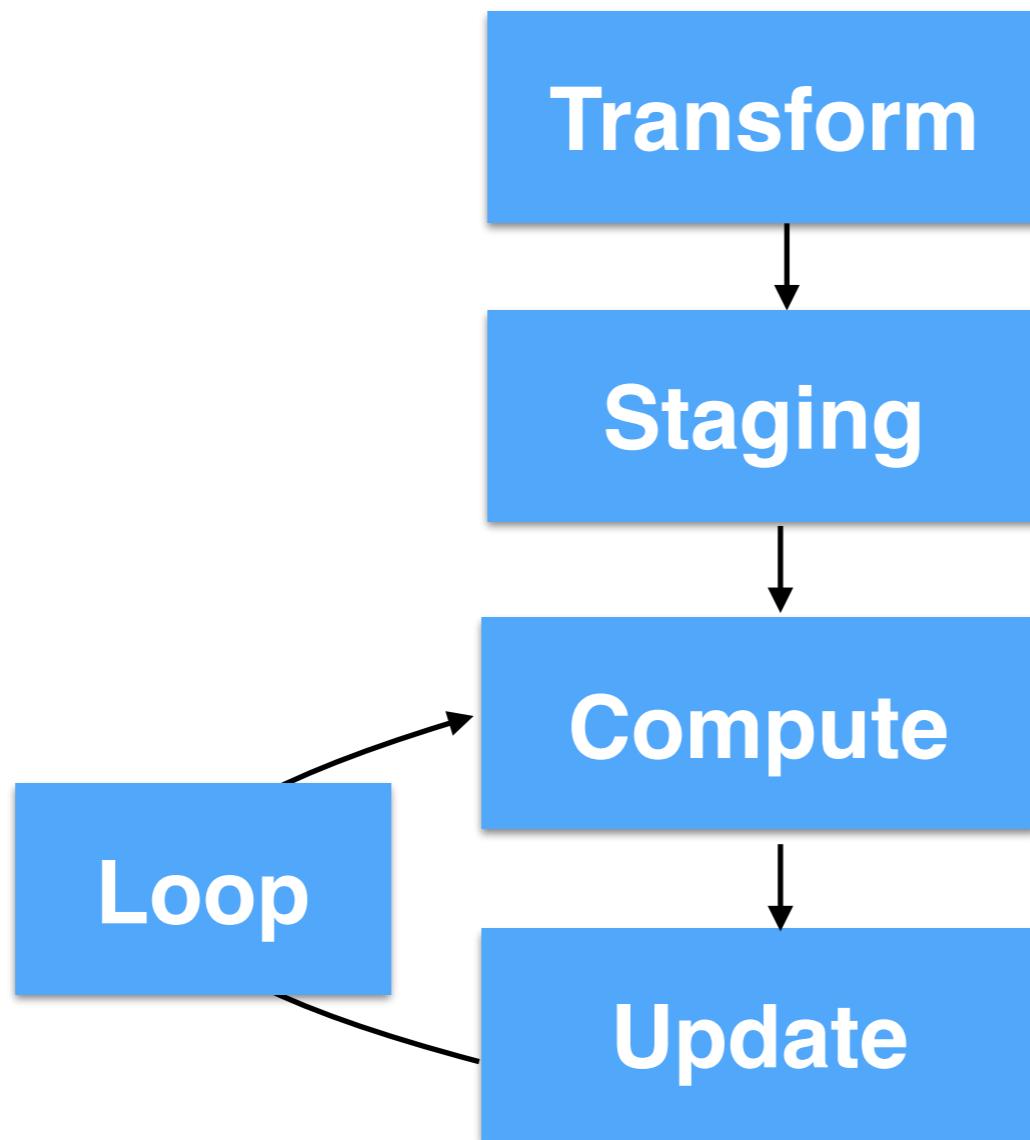




UDF-based Abstraction

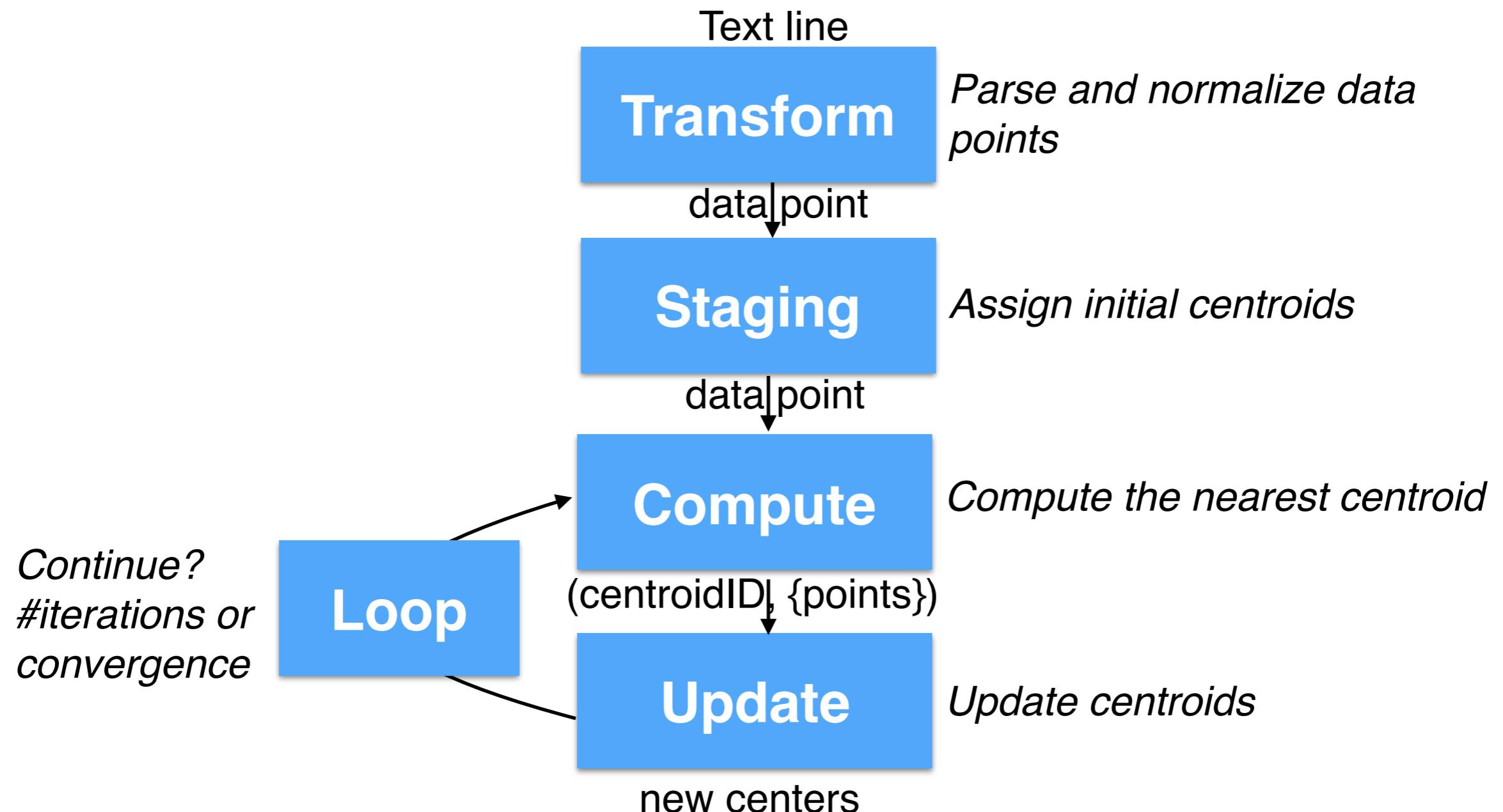


Logical Abstraction



ML Abstraction

- K-means -



ML Abstraction

- K-means -

Text line

Transform

data point

Parse and normalize data
points

```
public KeyValuePair compute(double[] input, Context context) {  
    1 ArrayList<double[]> centers = (ArrayList<double[]>)  
        context.getByName("centers");  
    2 double min = Double.MAX_VALUE;  
    3 int minIndex = 0;  
    4 for (int j = 0; j < centers.size(); j++) {  
        5     double dist = dist(input, centers.get(j));  
        6     if (dist < min) {  
            7         min = dist;  
            8         minIndex = j;  
        9     }  
    10 }  
    11 return new KeyValuePair(minIndex, new KeyValuePair<>(1, input));  
}
```

Continue

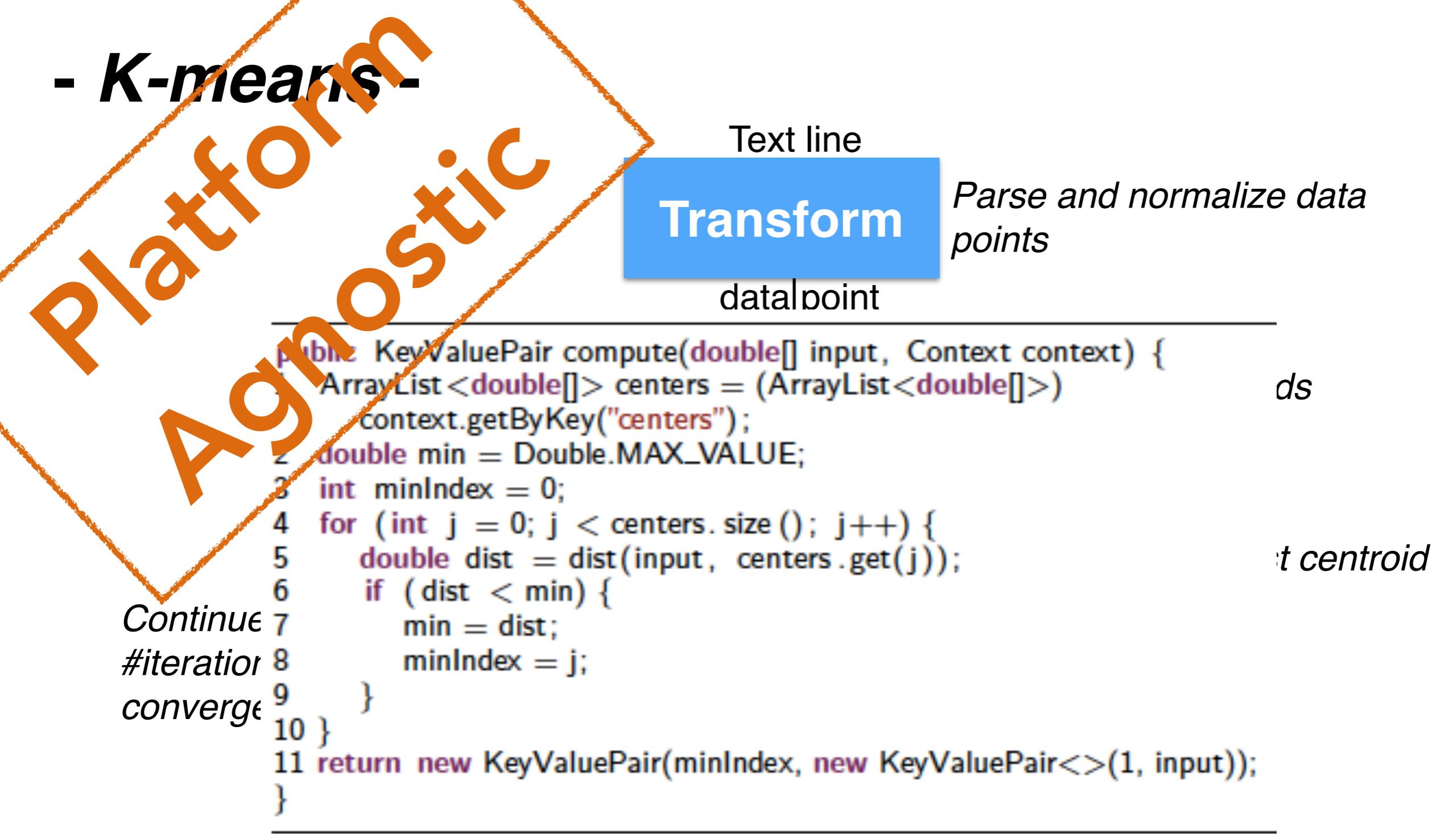
#iteration

converge

ds

at centroid

ML Abstraction



ML Abstraction

- K-means -

Platform Agnostic

Text line

Transform

data point

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Parse and normalize data
points

```
public KeyValuePair compute(double[] input, Context context) {  
    1   ArrayList<double[]> centers = (ArrayList<double[]>)  
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}
```

Continue
#iteration
converge

ML Abstraction

- K-means -

Platform Agnostic

Text line

Transform

data point

```
public KeyValuePair compute(double[] input, Context context) {  
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    9     }  
   10 }  
   11 return new KeyValuePair(minIndex, new KeyValuePair<>(1, input));  
}
```

Parse and normalize data points

Fast

of

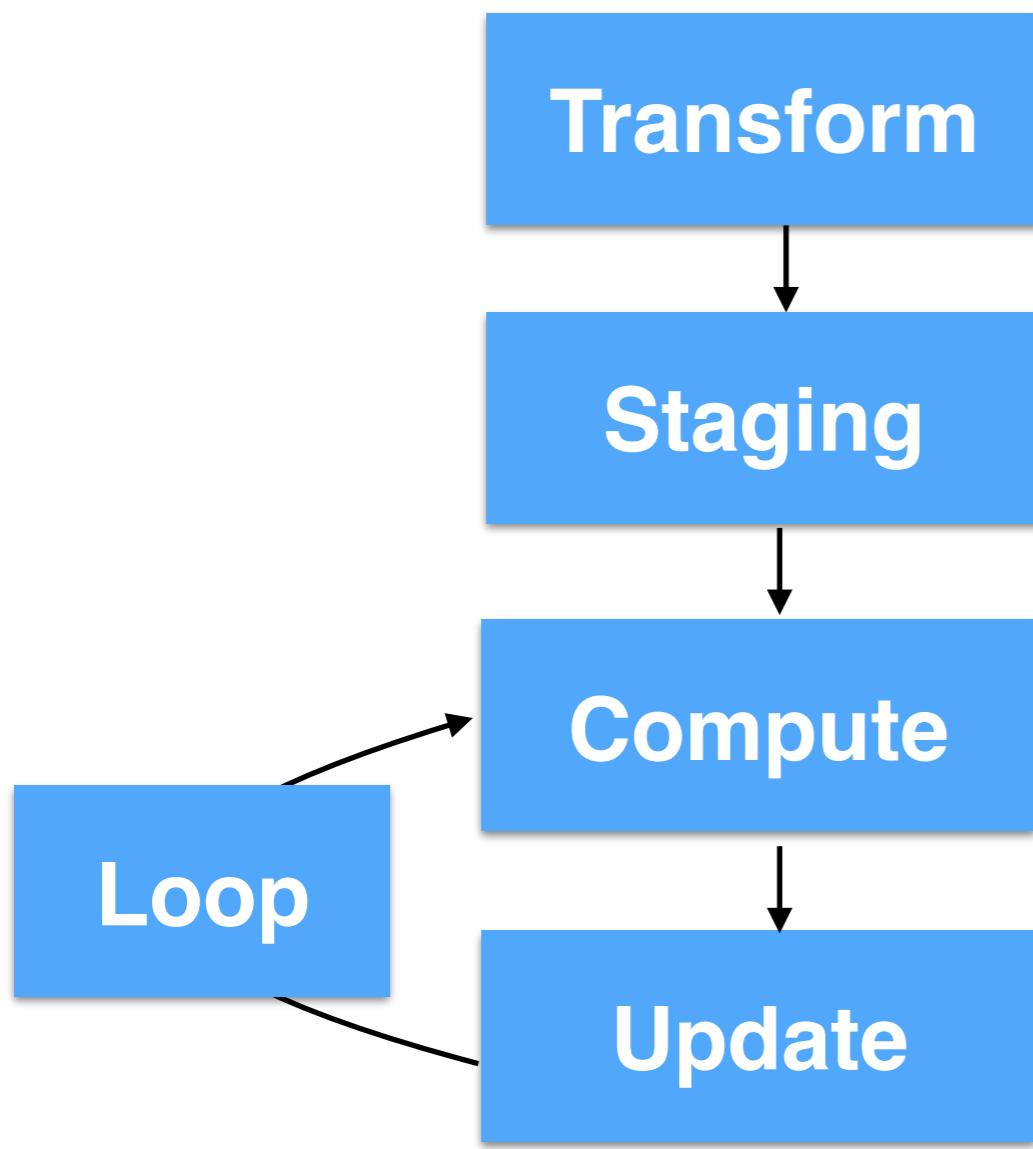
Use

Continue
#iteration
converge

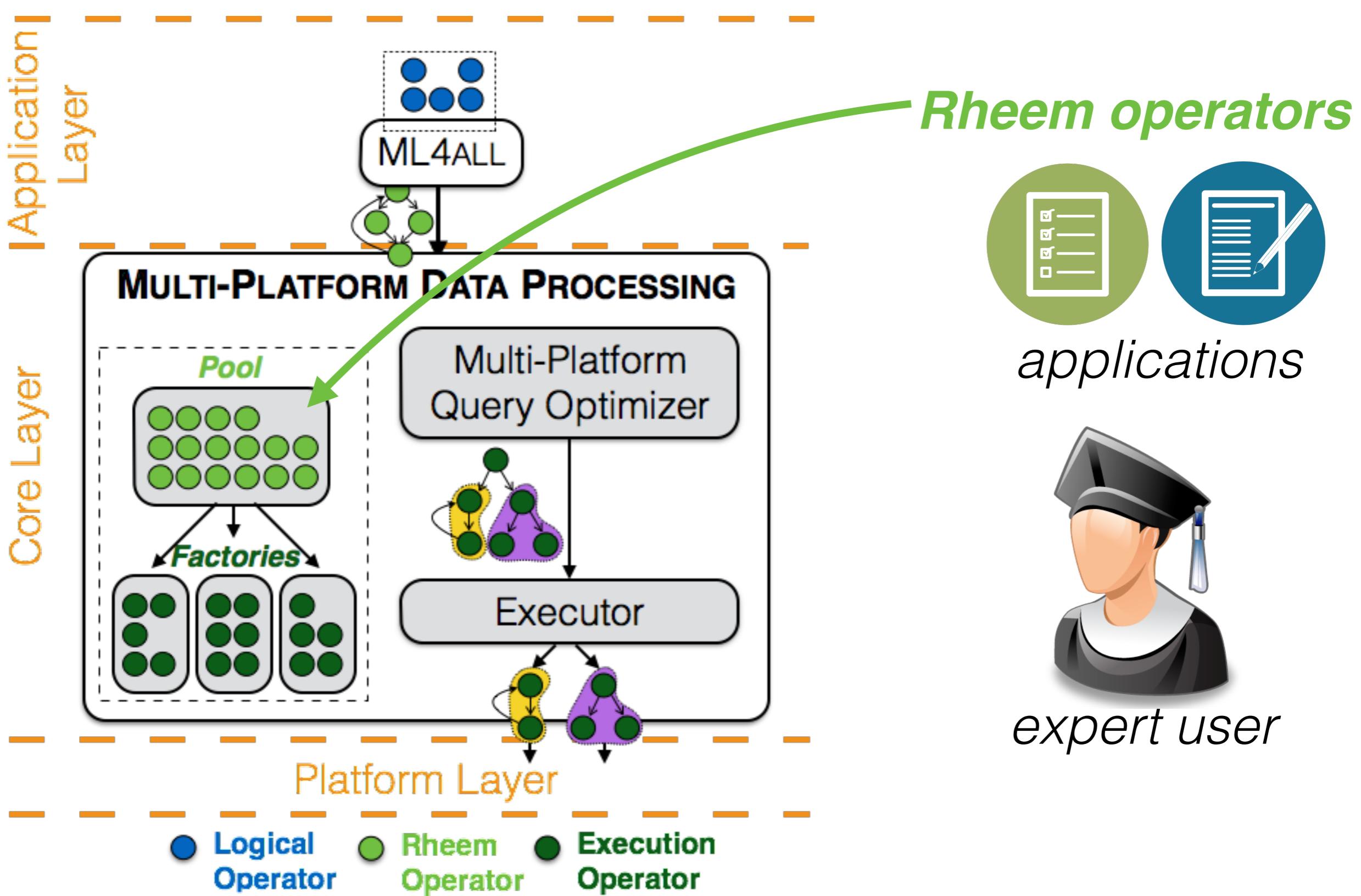
Adaptability

ML Abstraction

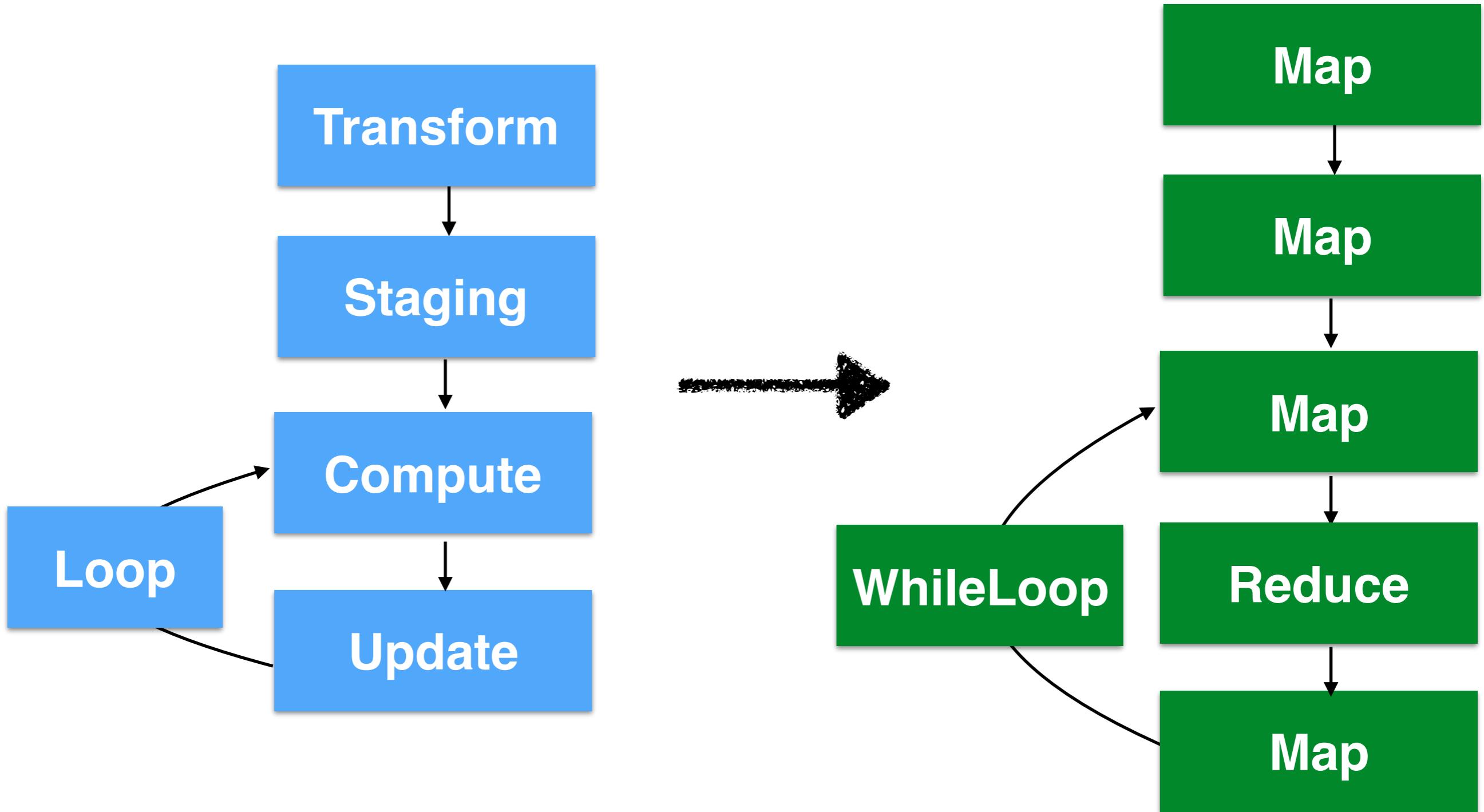
Problem 1:
Right
Application
Abstraction?



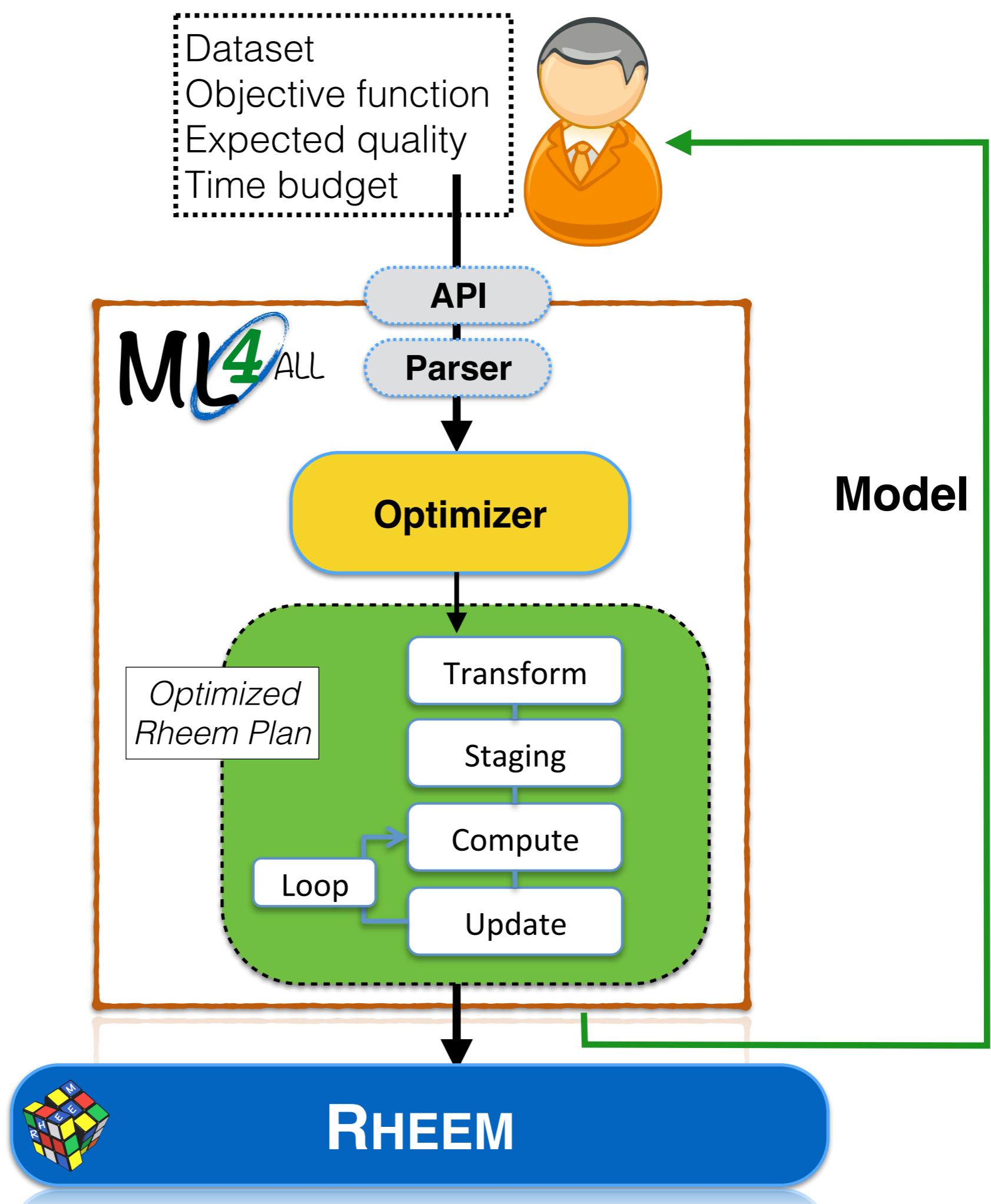
Logical Plan → RHEEM Plan

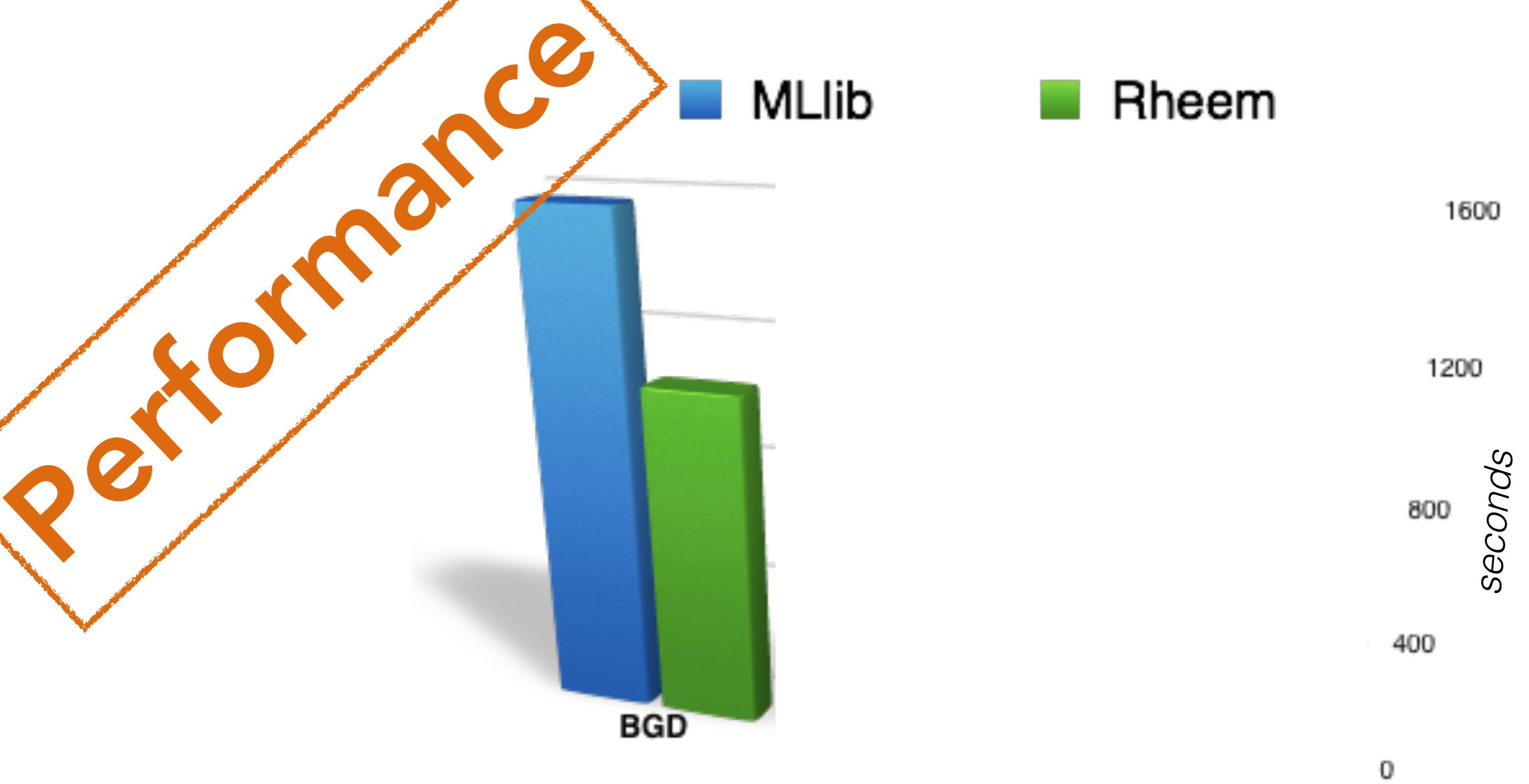


Physical Abstraction



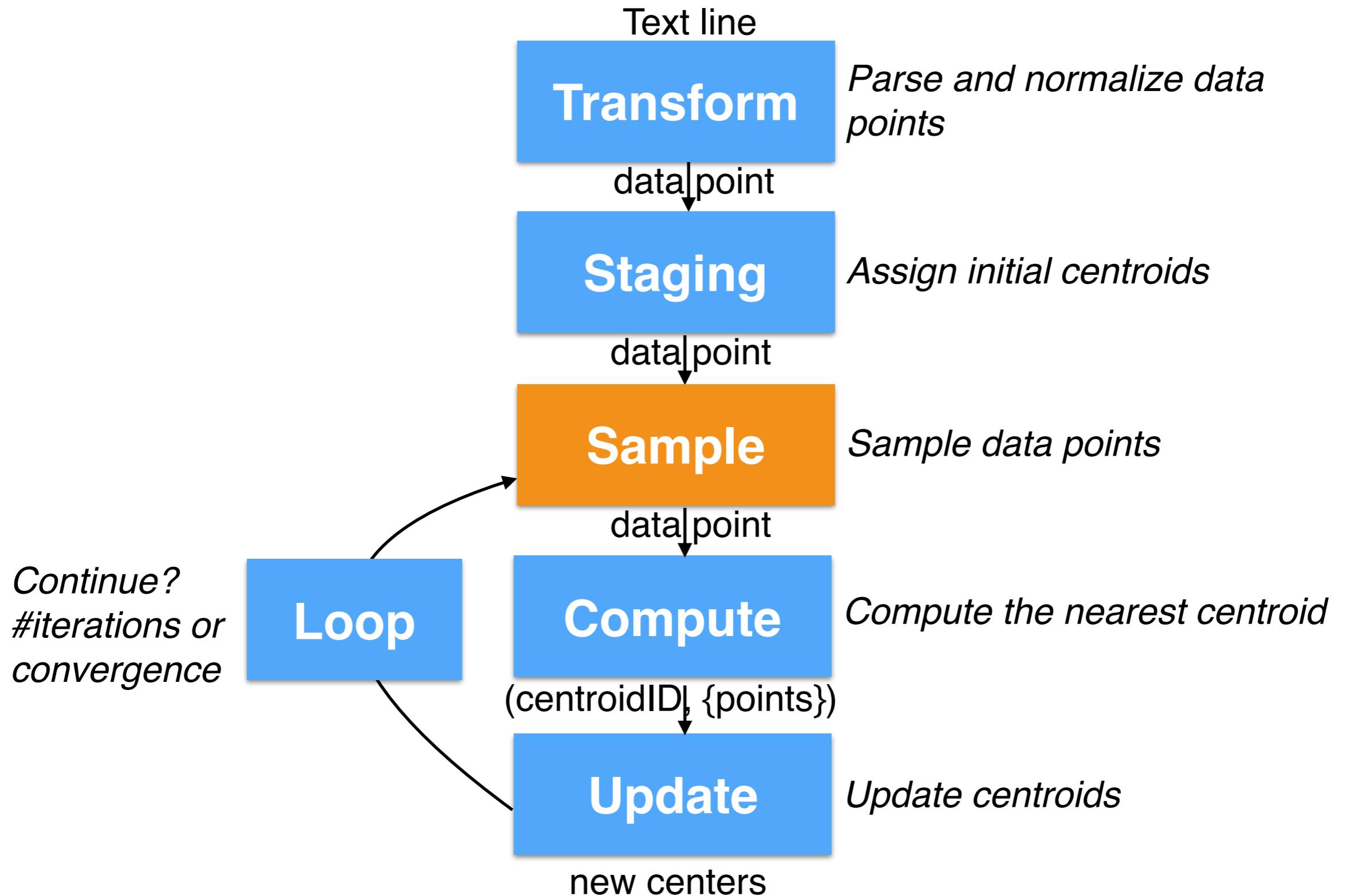
Logical Plan → RHEEM Plan



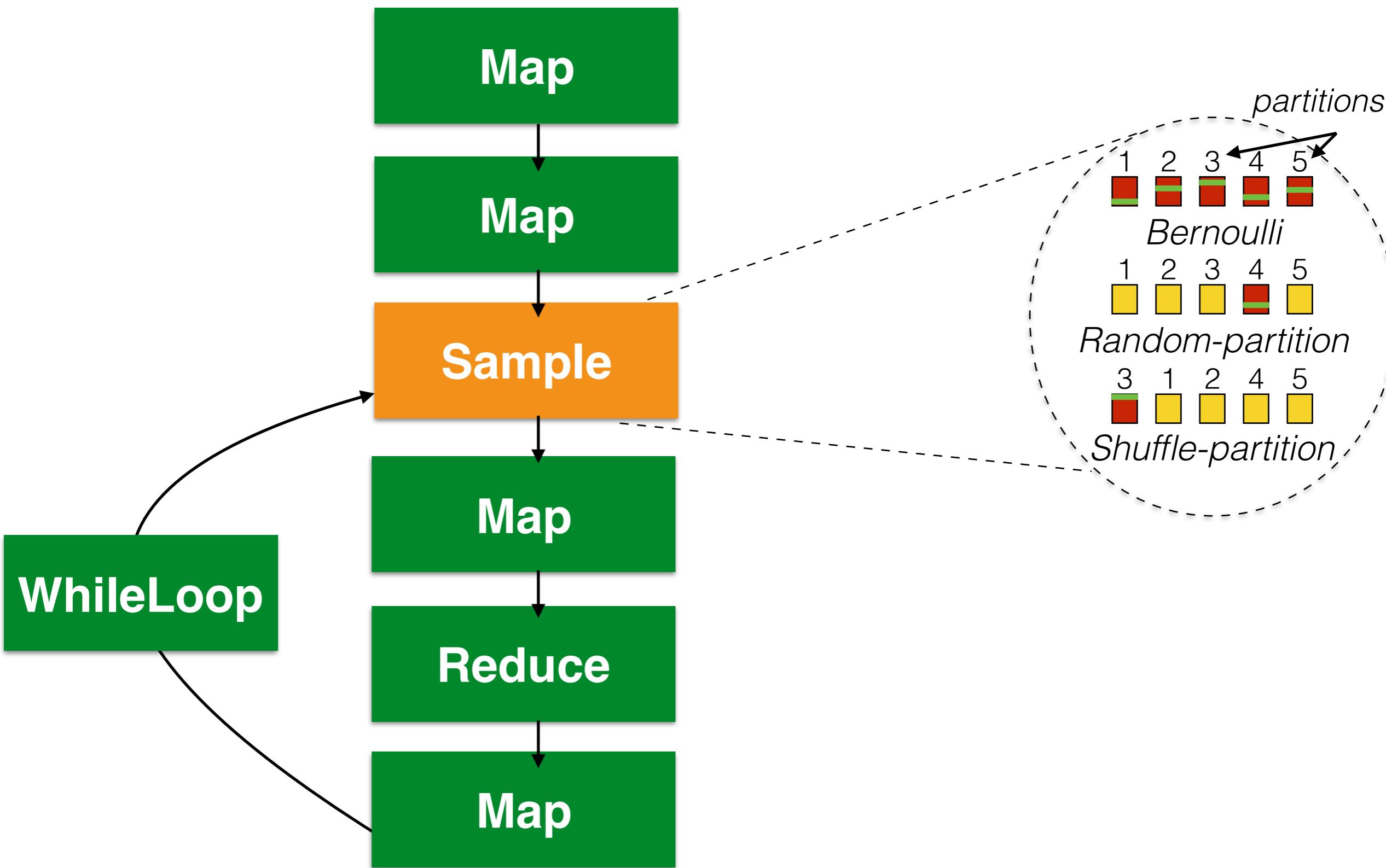


ML with RHEEM vs. MLlib

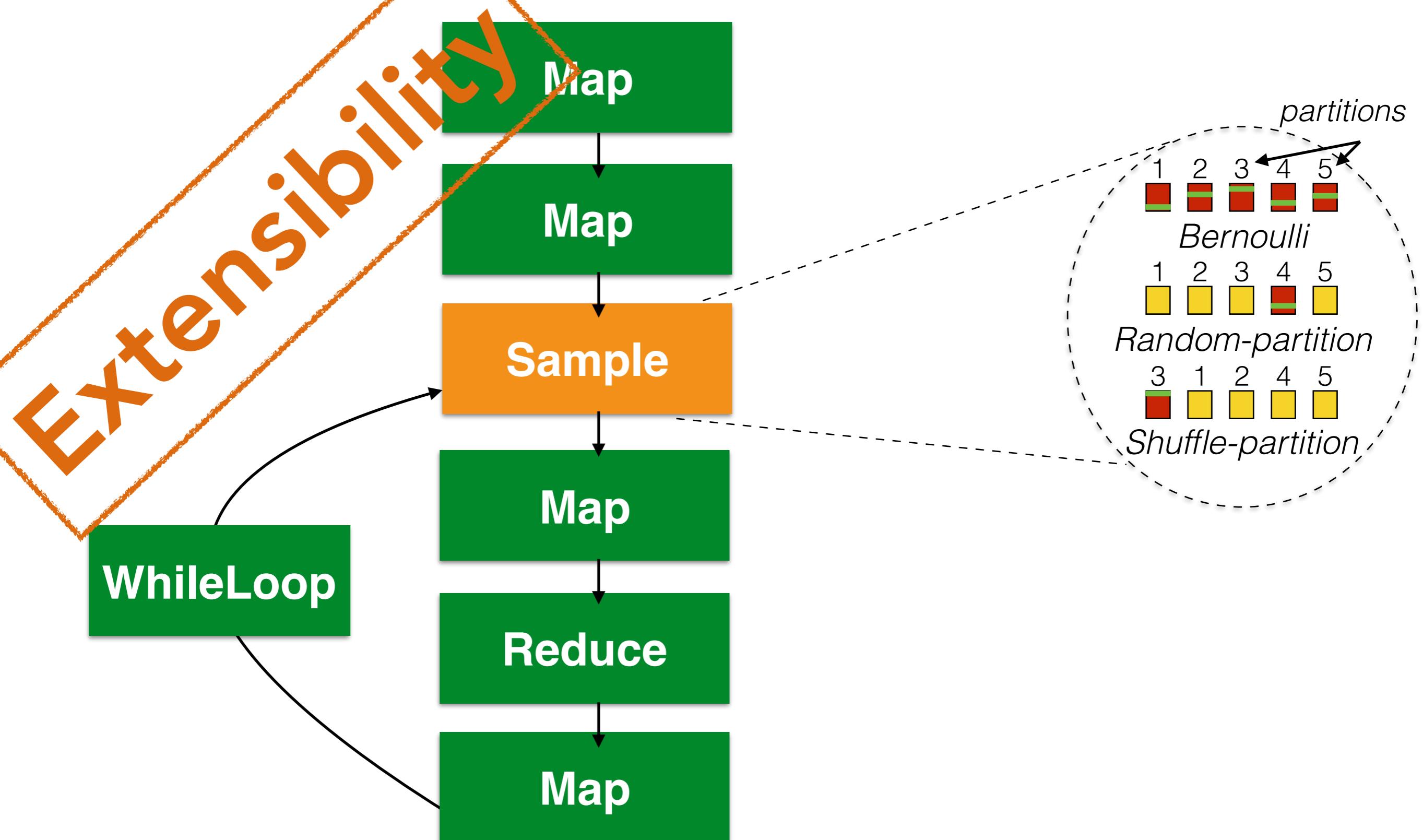
SVM on RHEEM



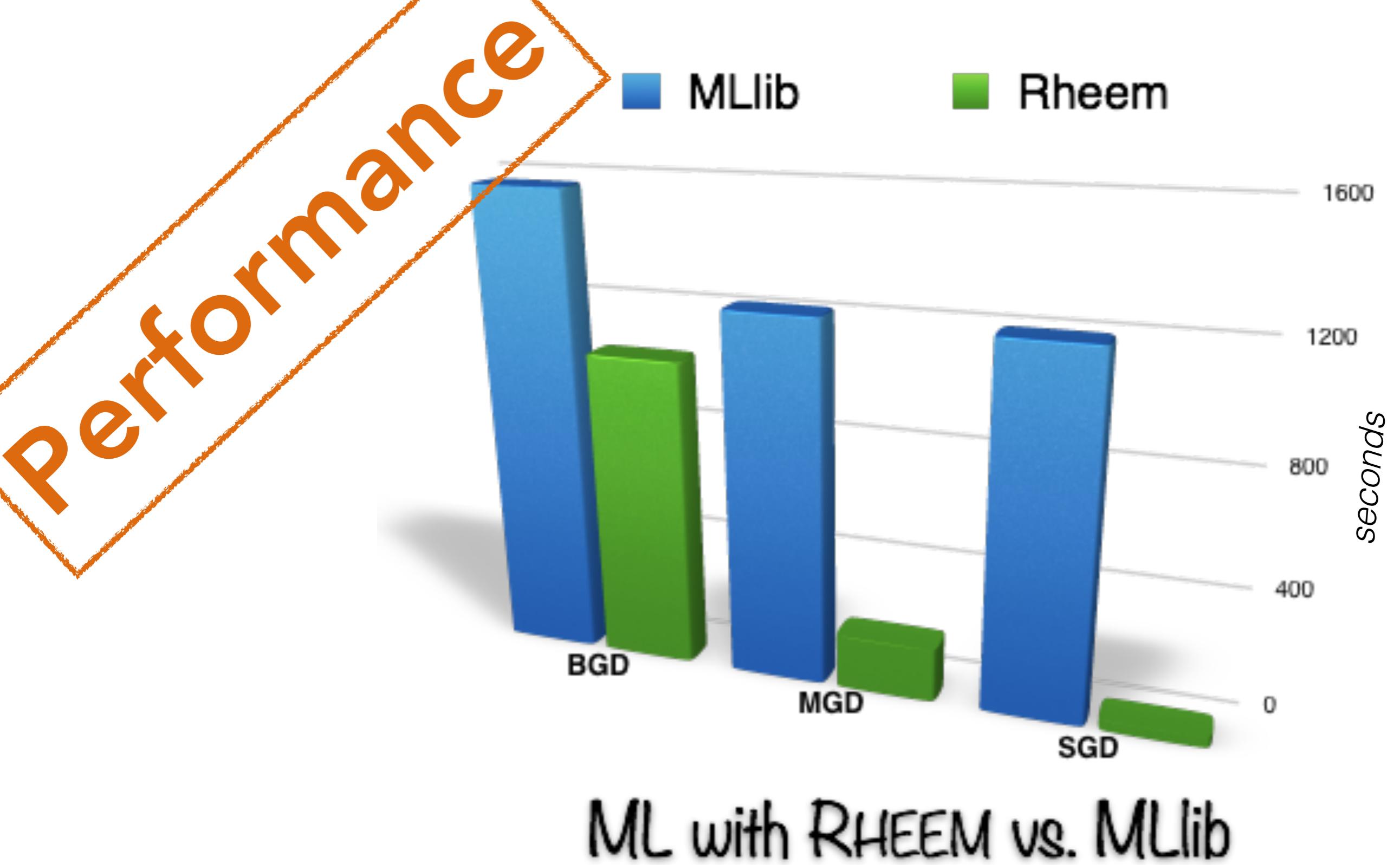
New Logical Operator



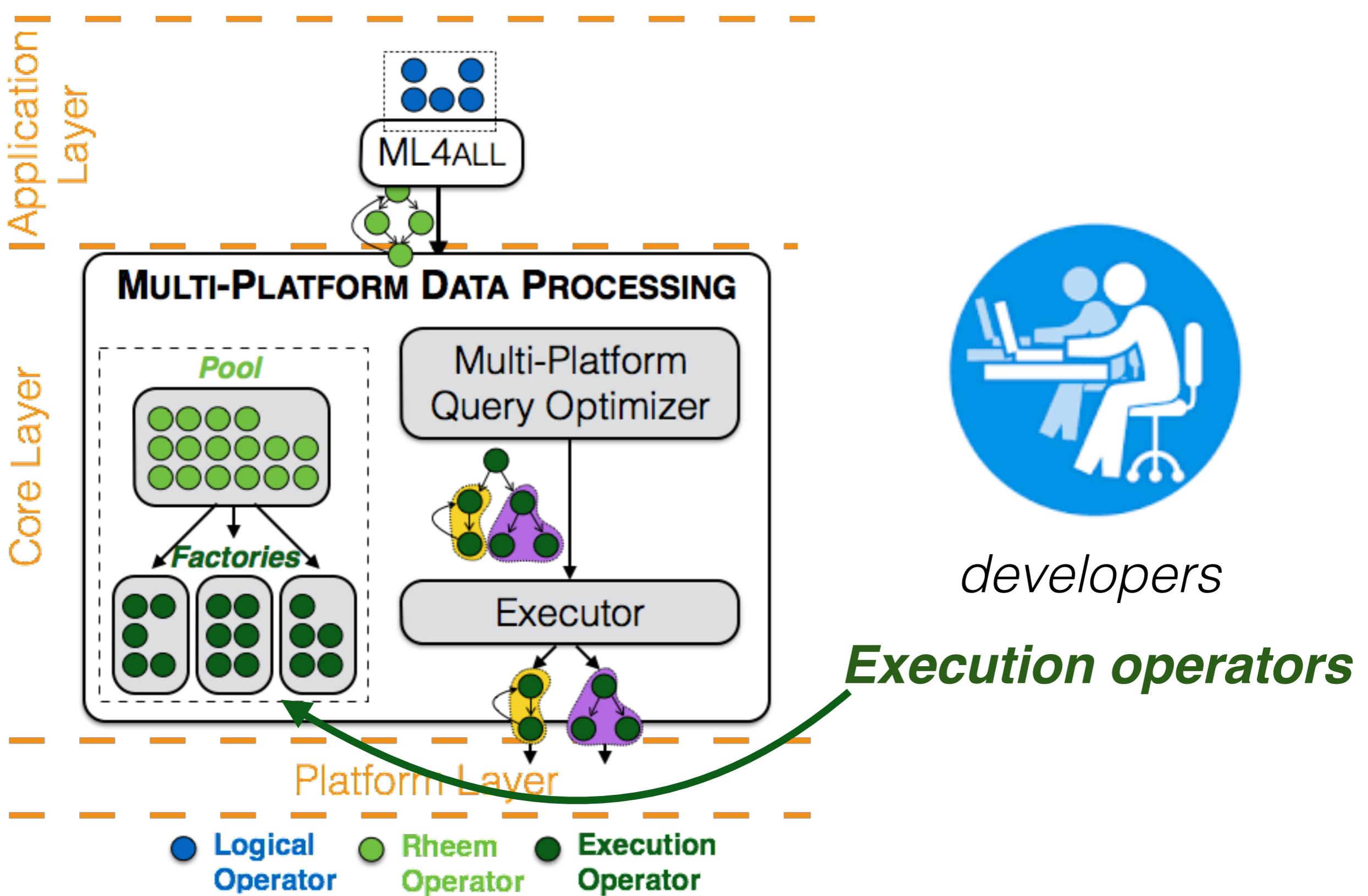
New RHEEM Operator



New RHEEM Operator

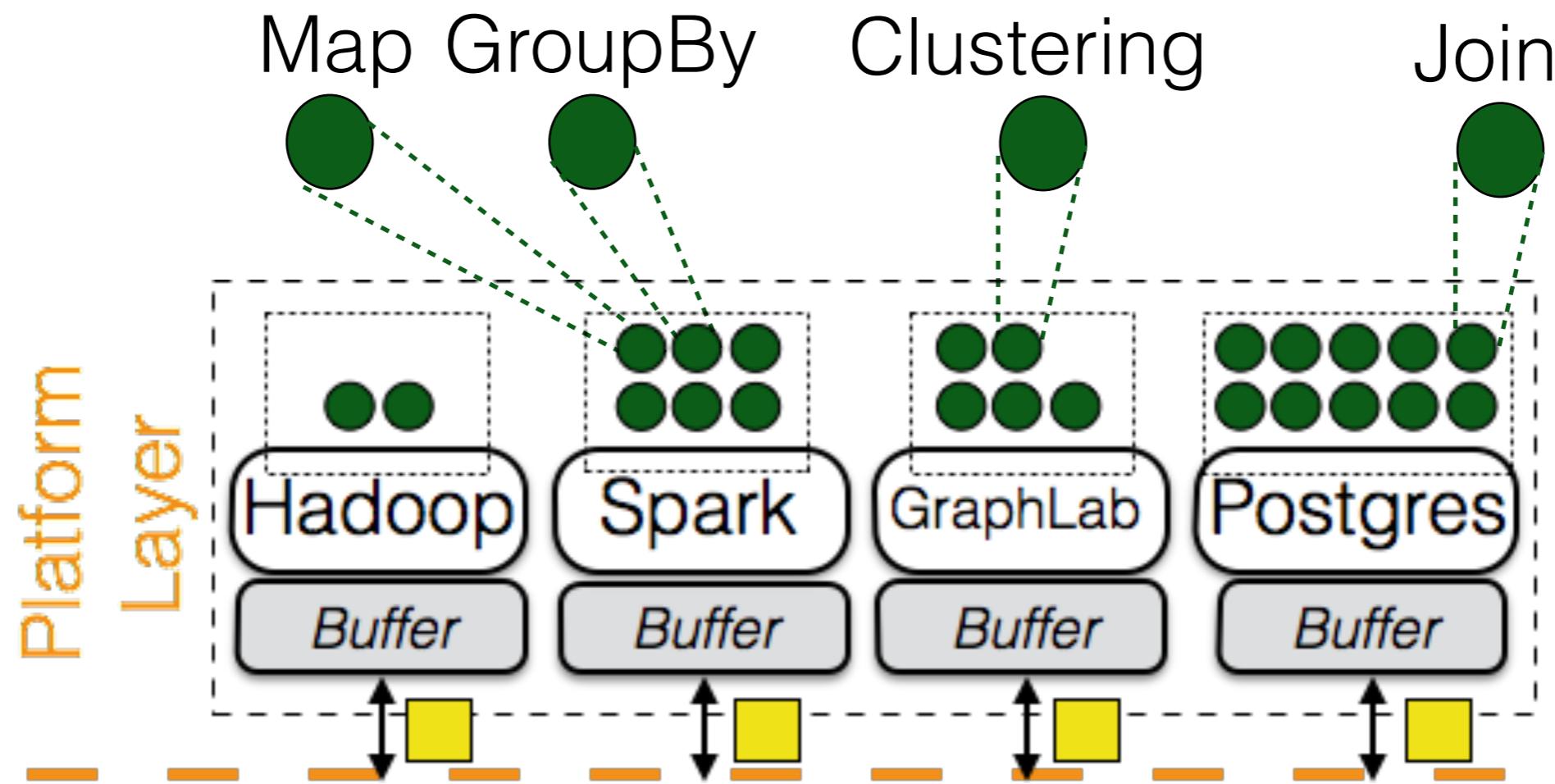


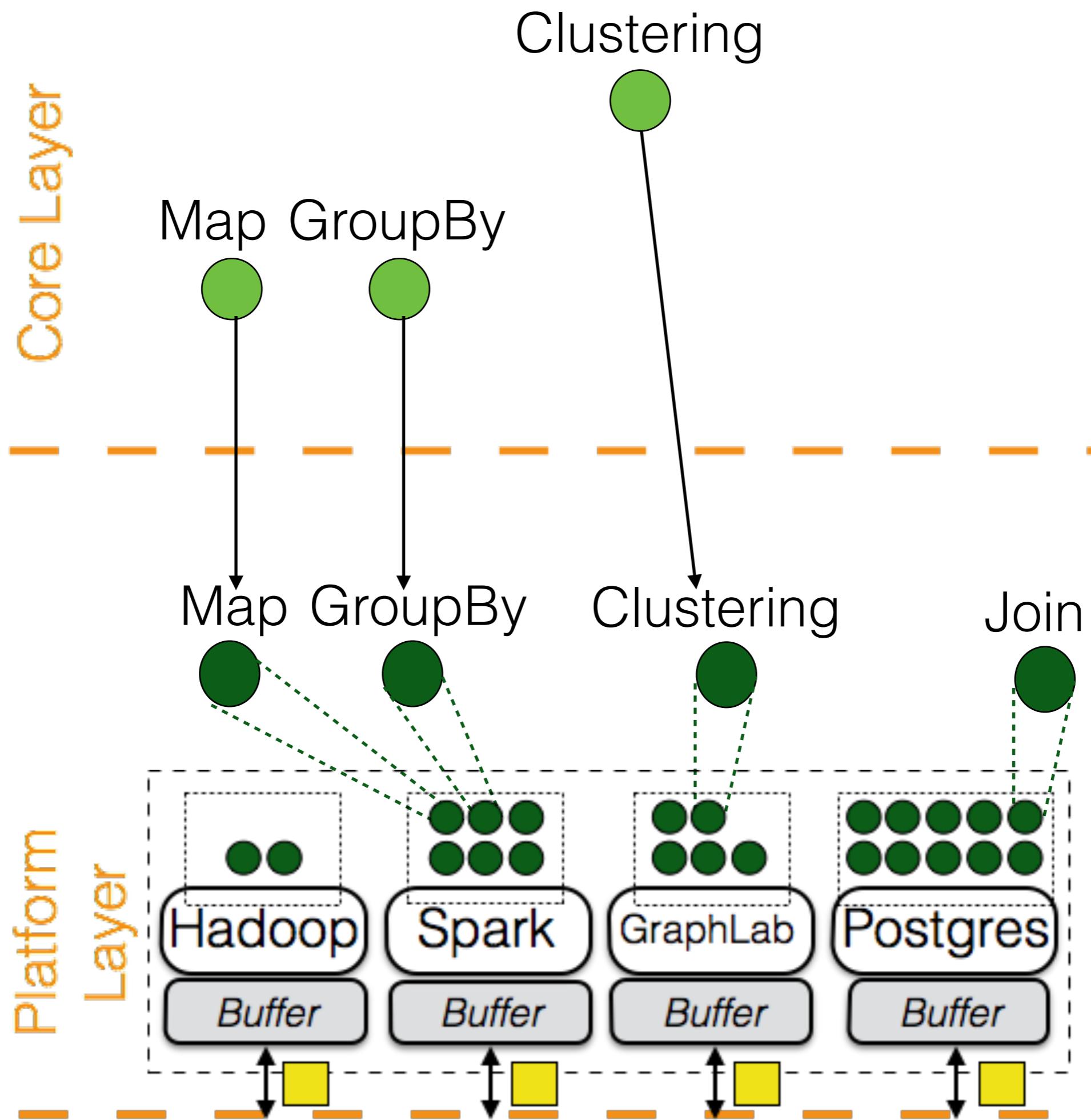
SVM on RHEEM

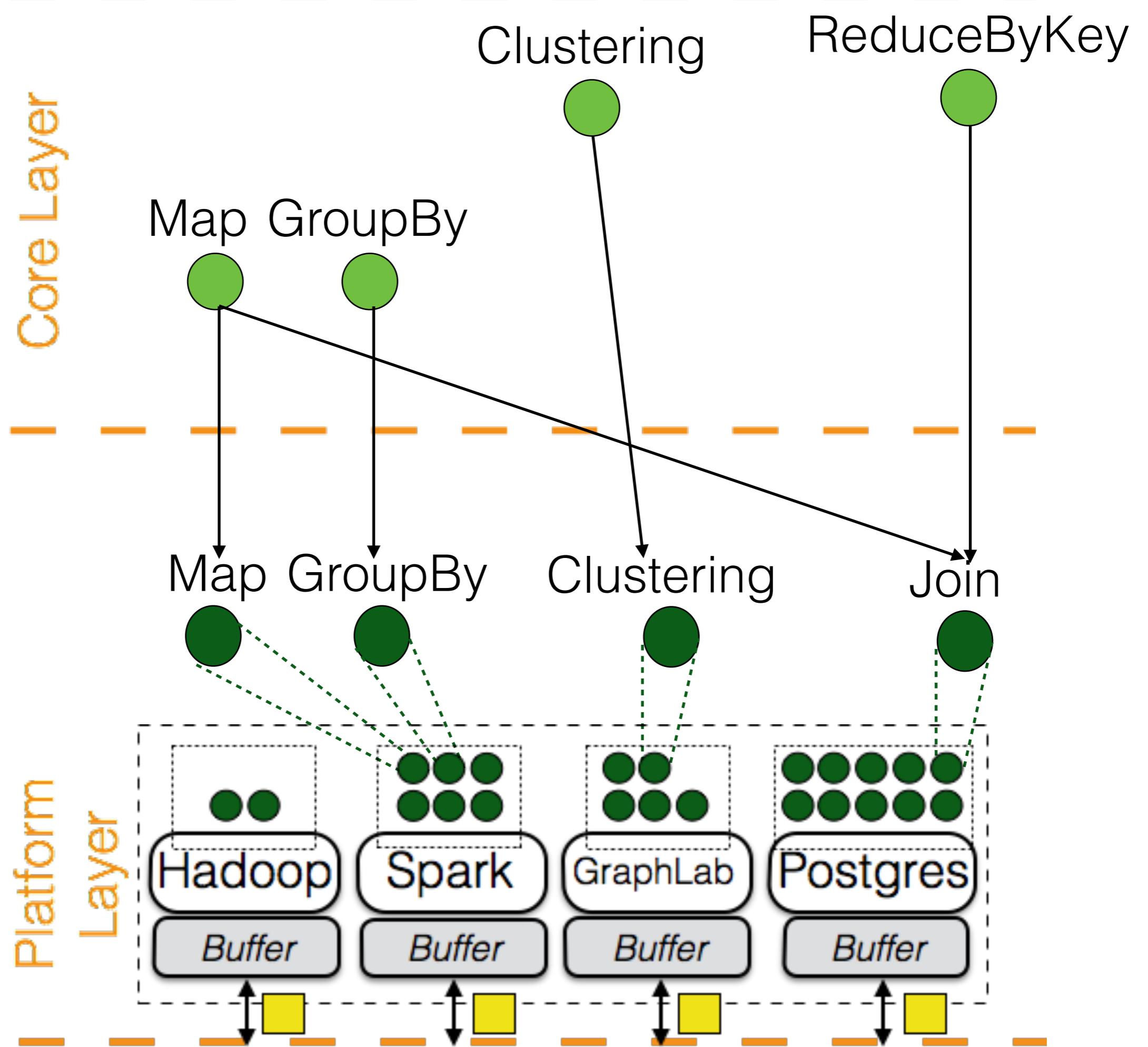


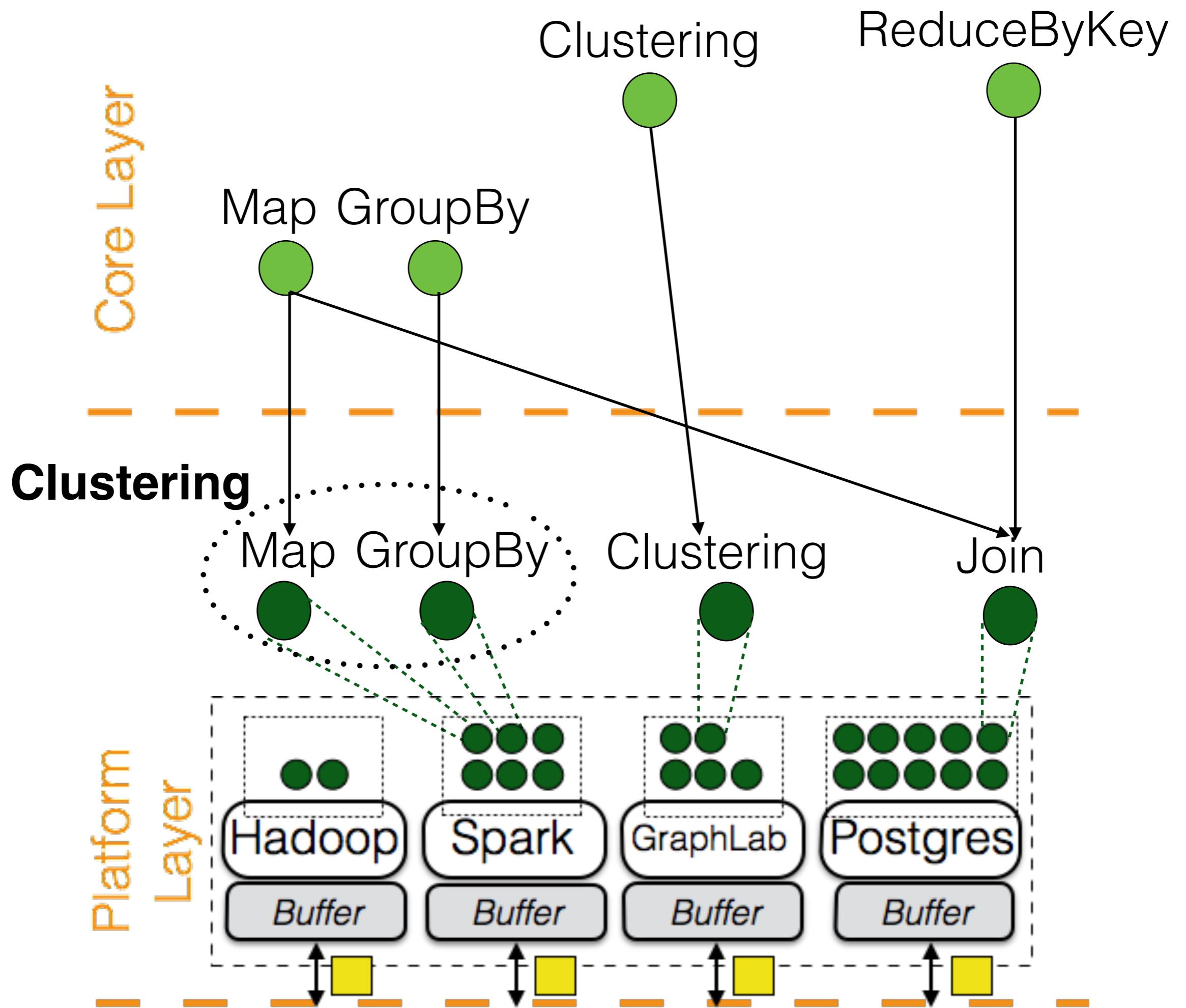
Execution Abstraction

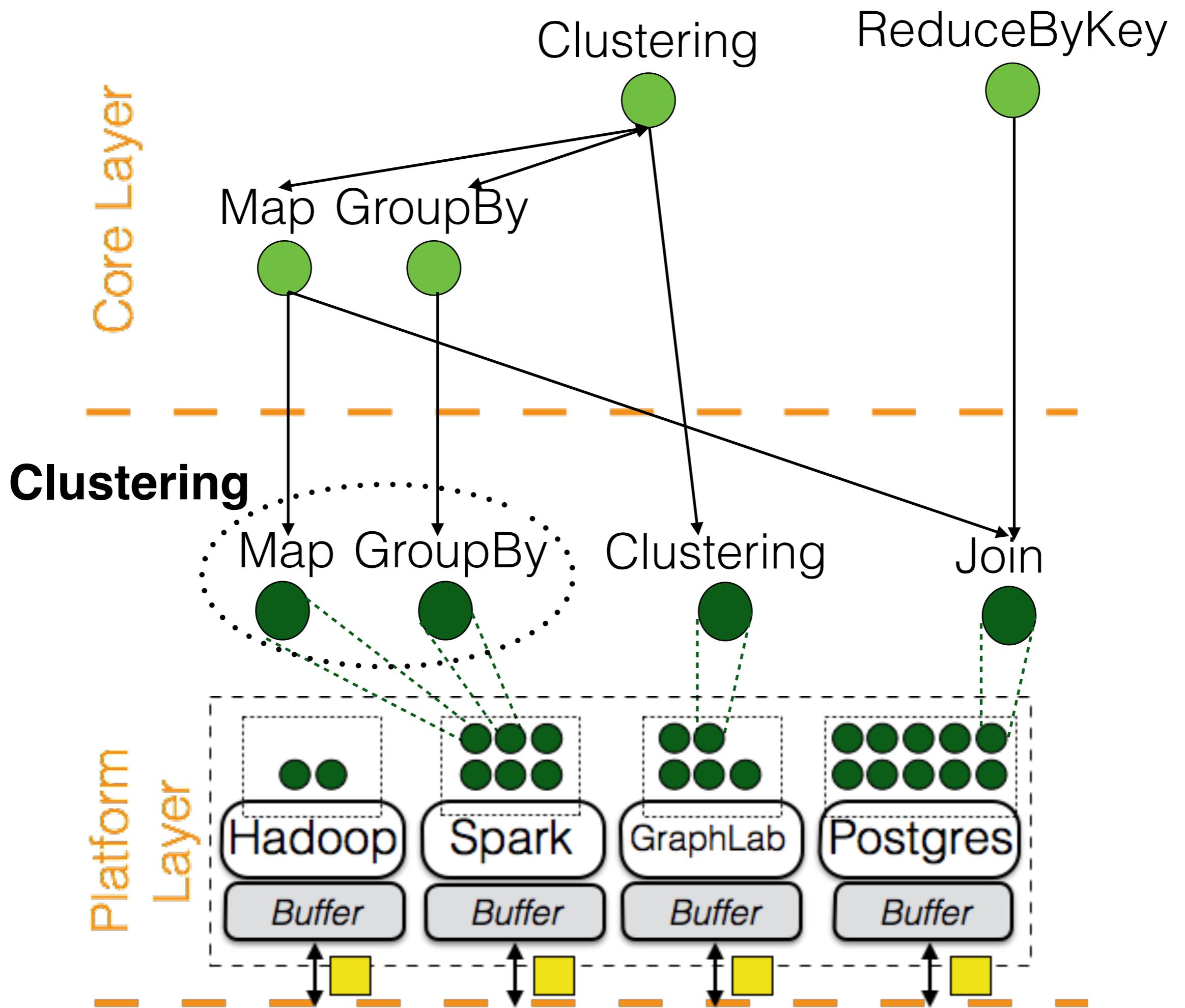
Core Layer



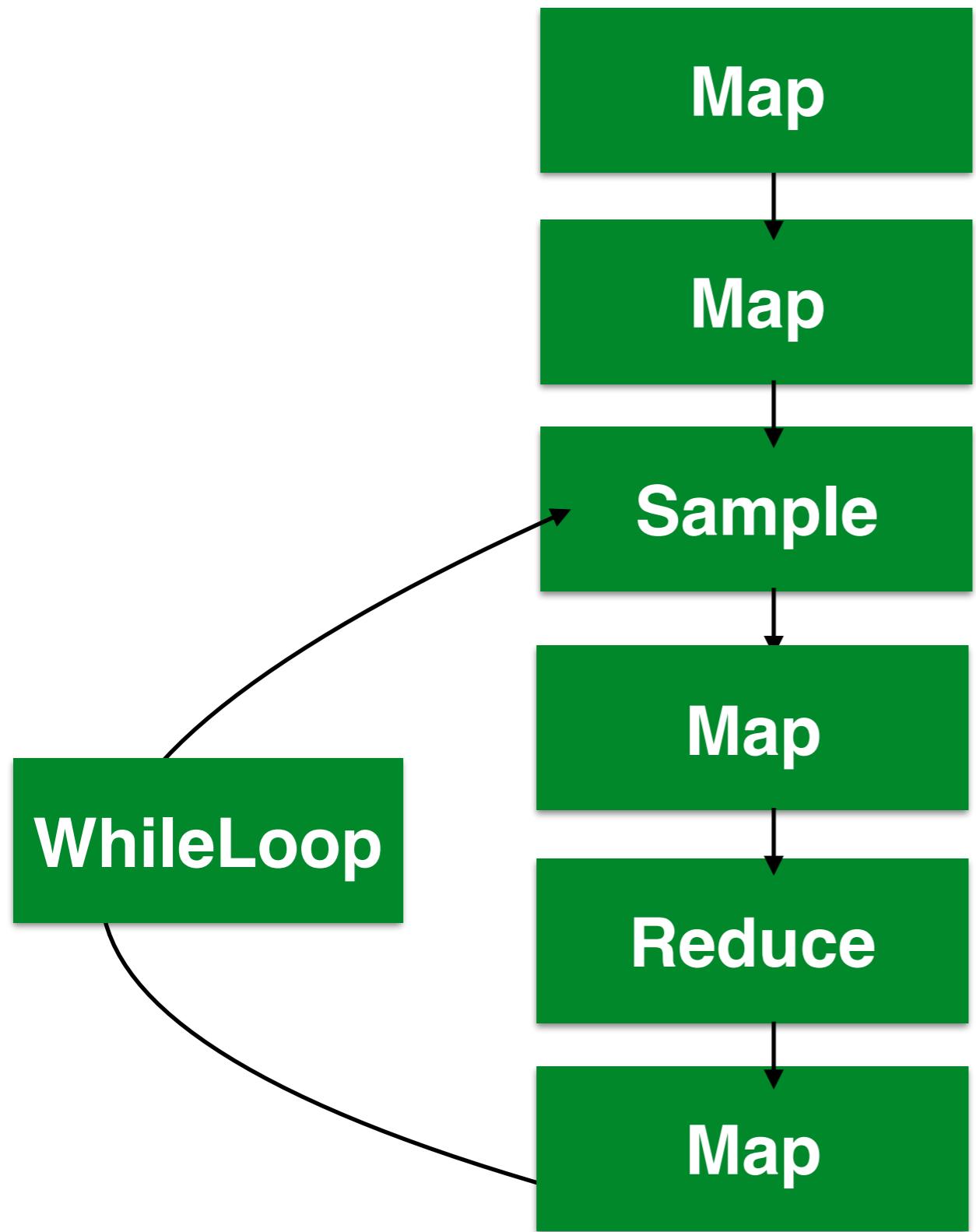






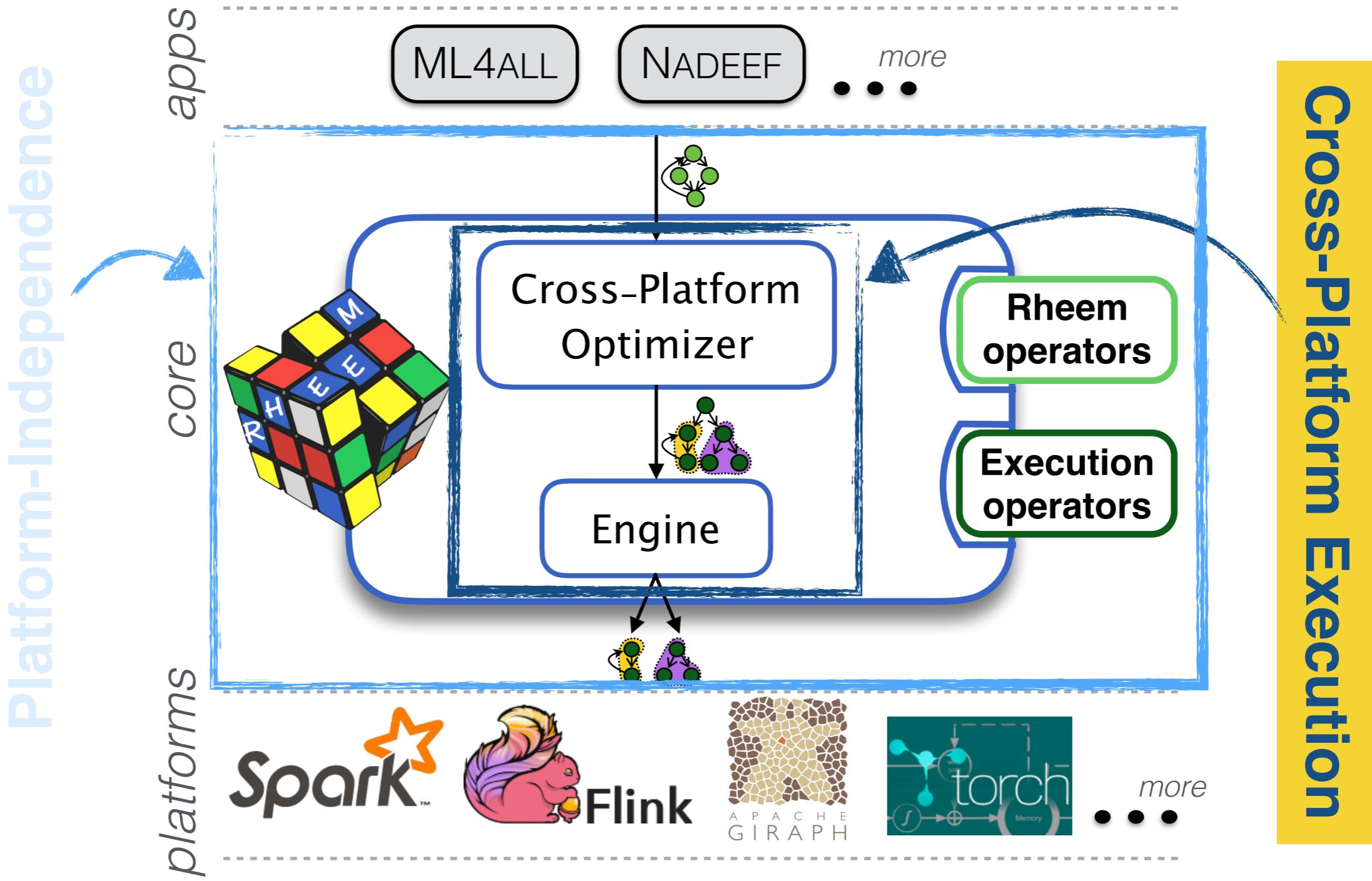
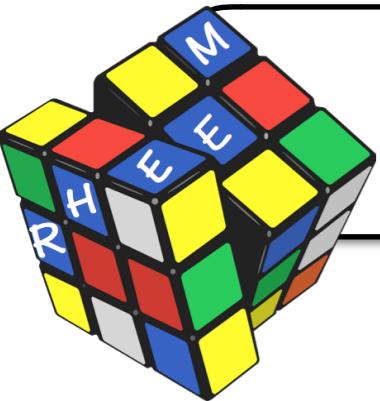


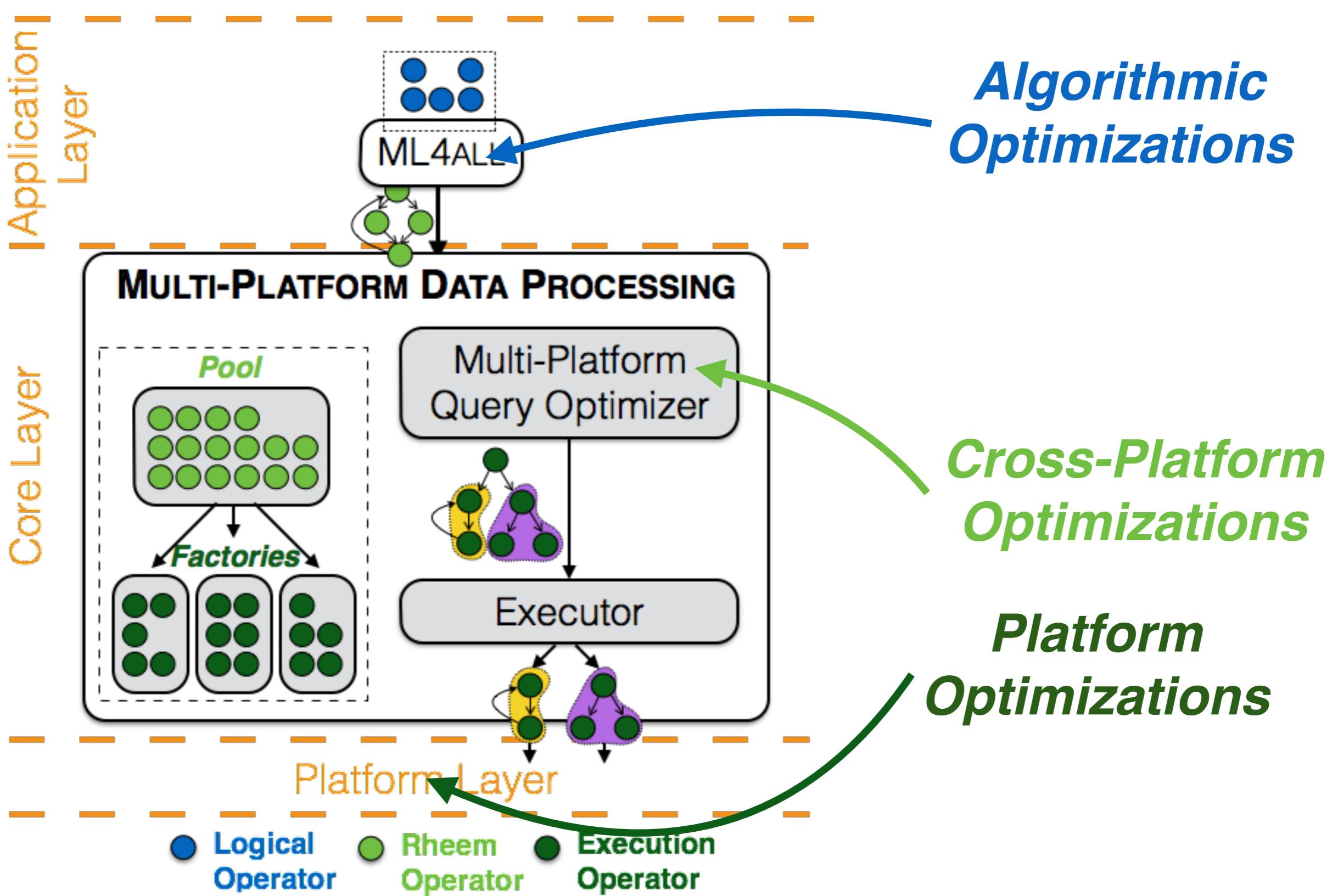
Problem 2:
Declarative
Operators and
Mappings?



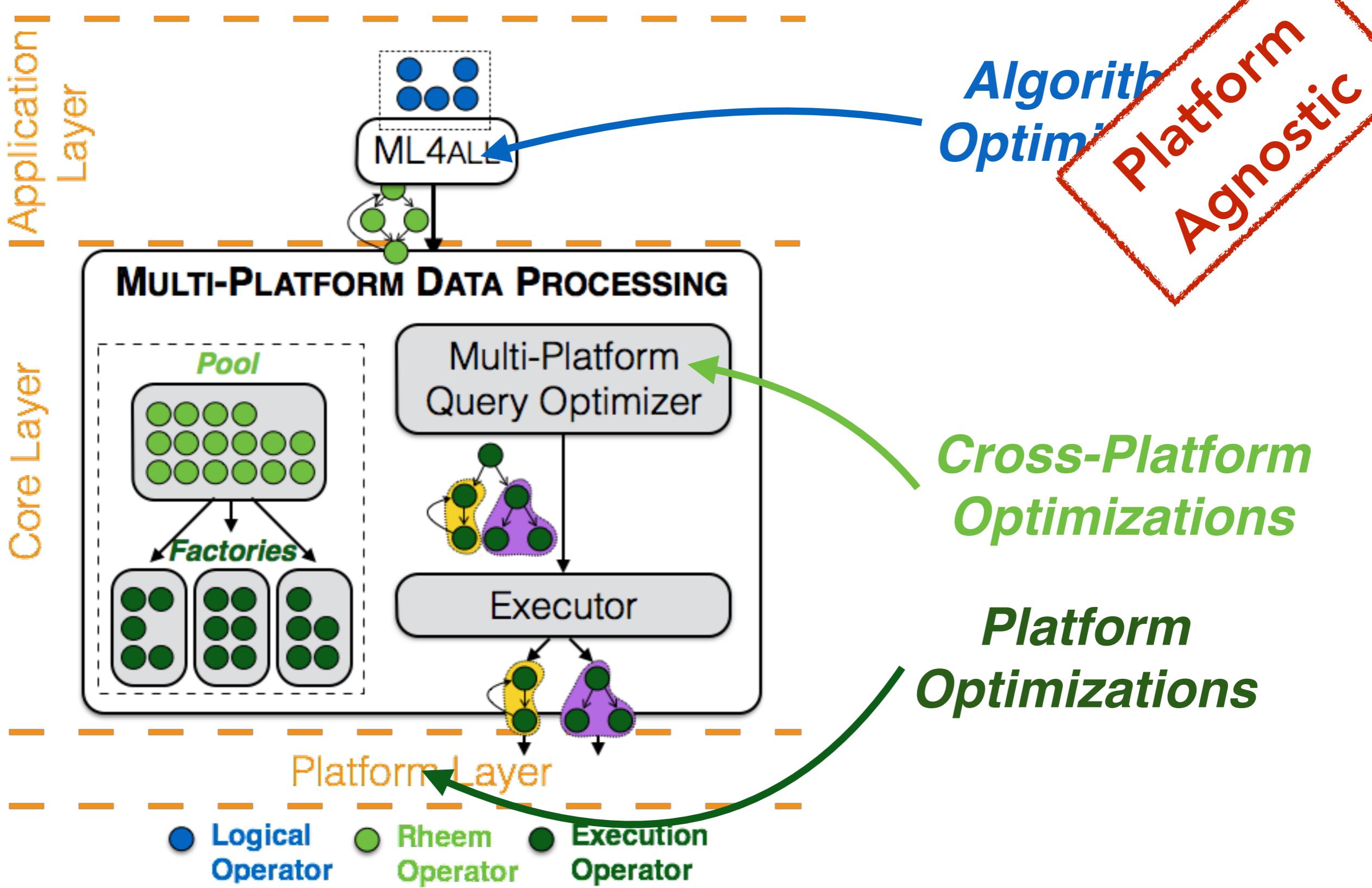
RHEEM Plan → Execution Plan

Agenda

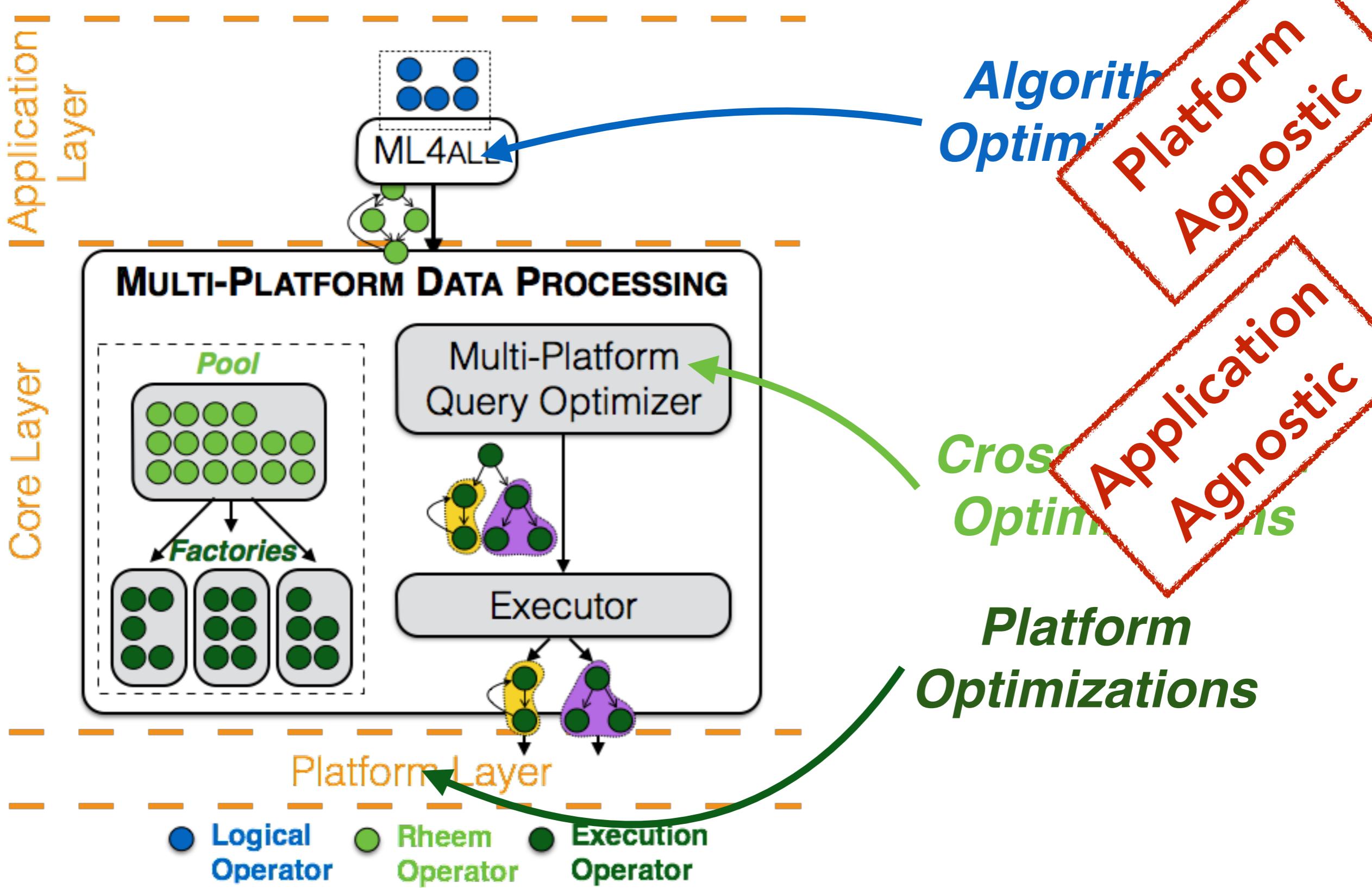




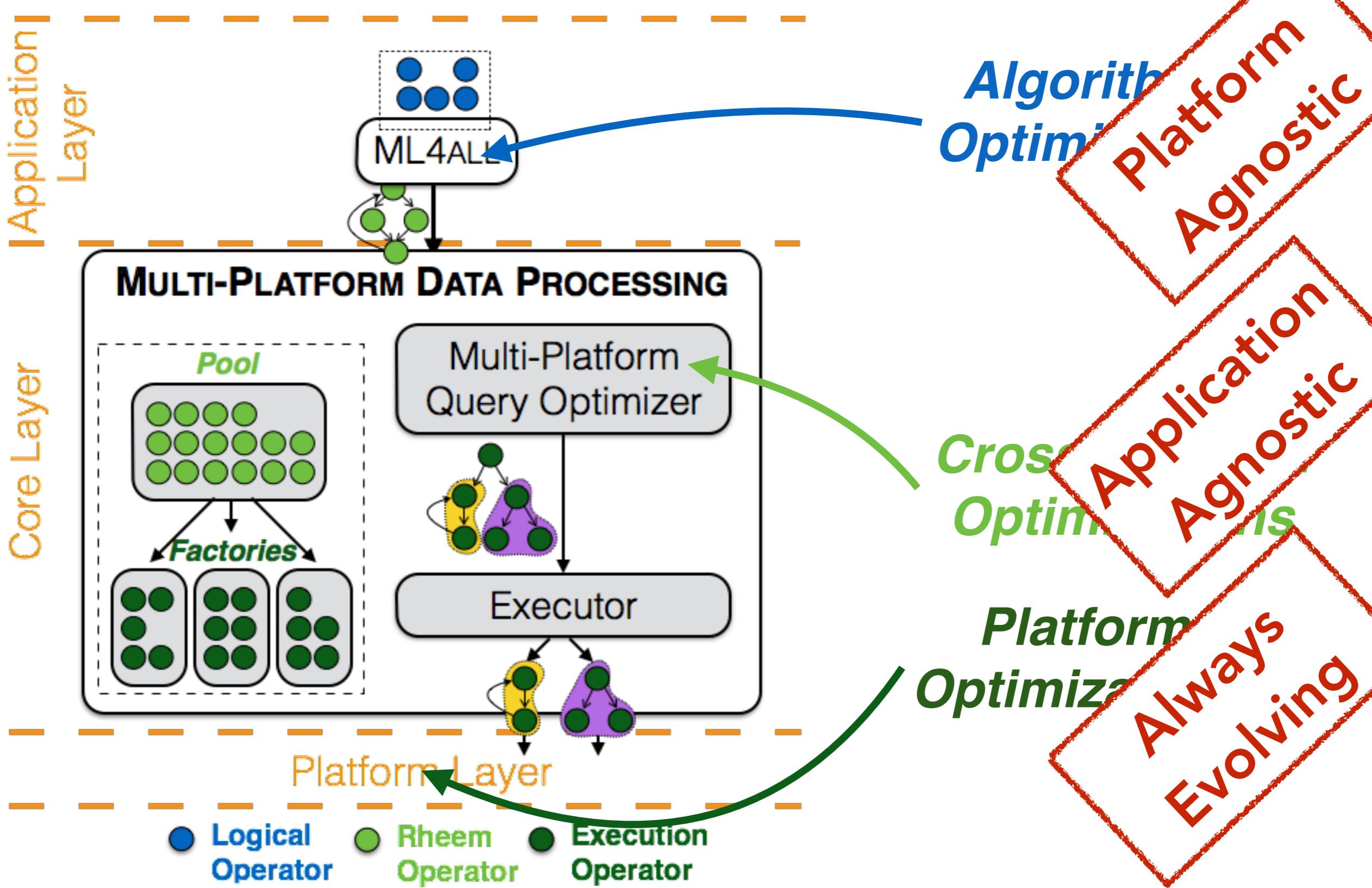
Multi-Layer Optimization



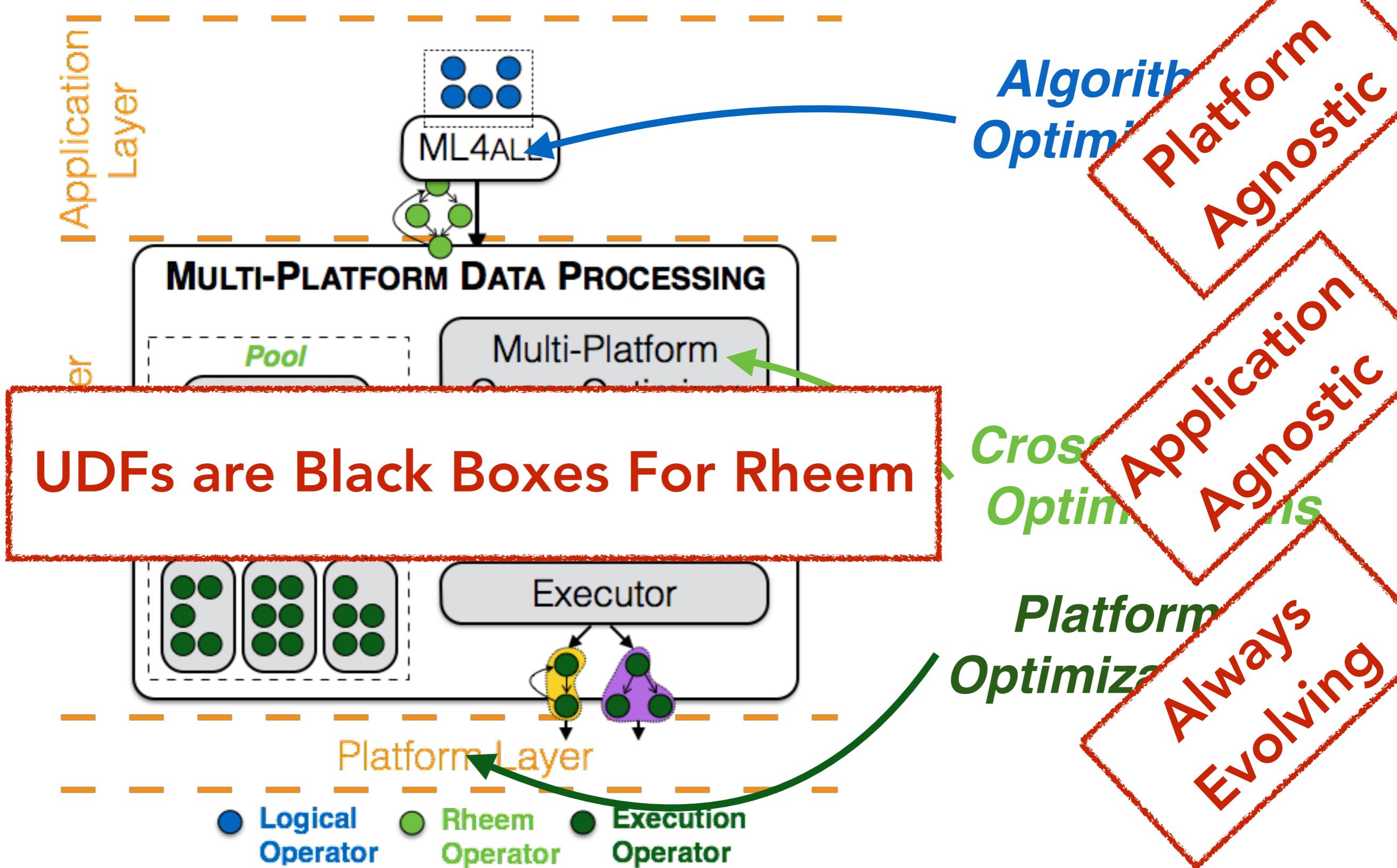
Multi-Layer Optimization



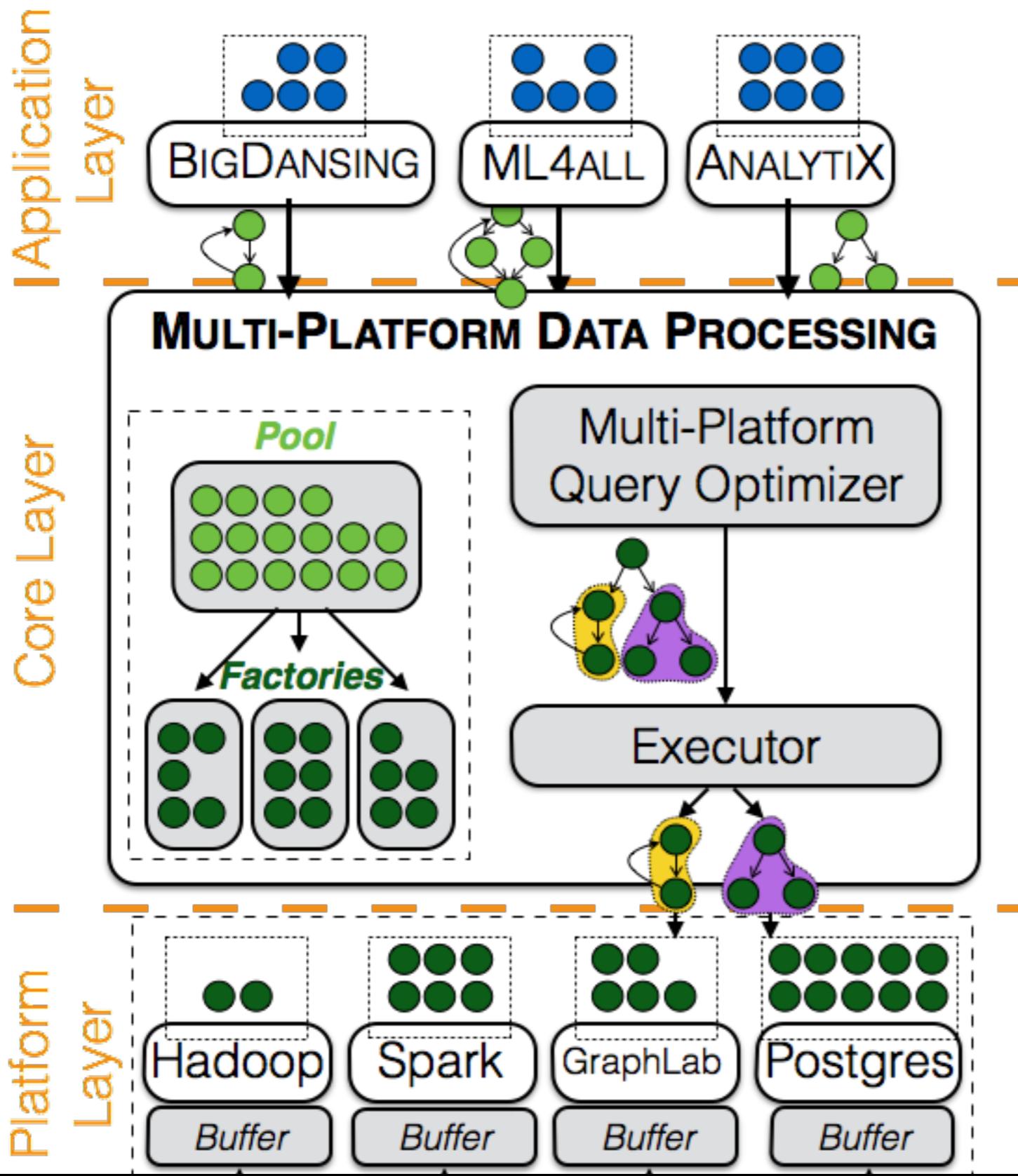
Multi-Layer Optimization



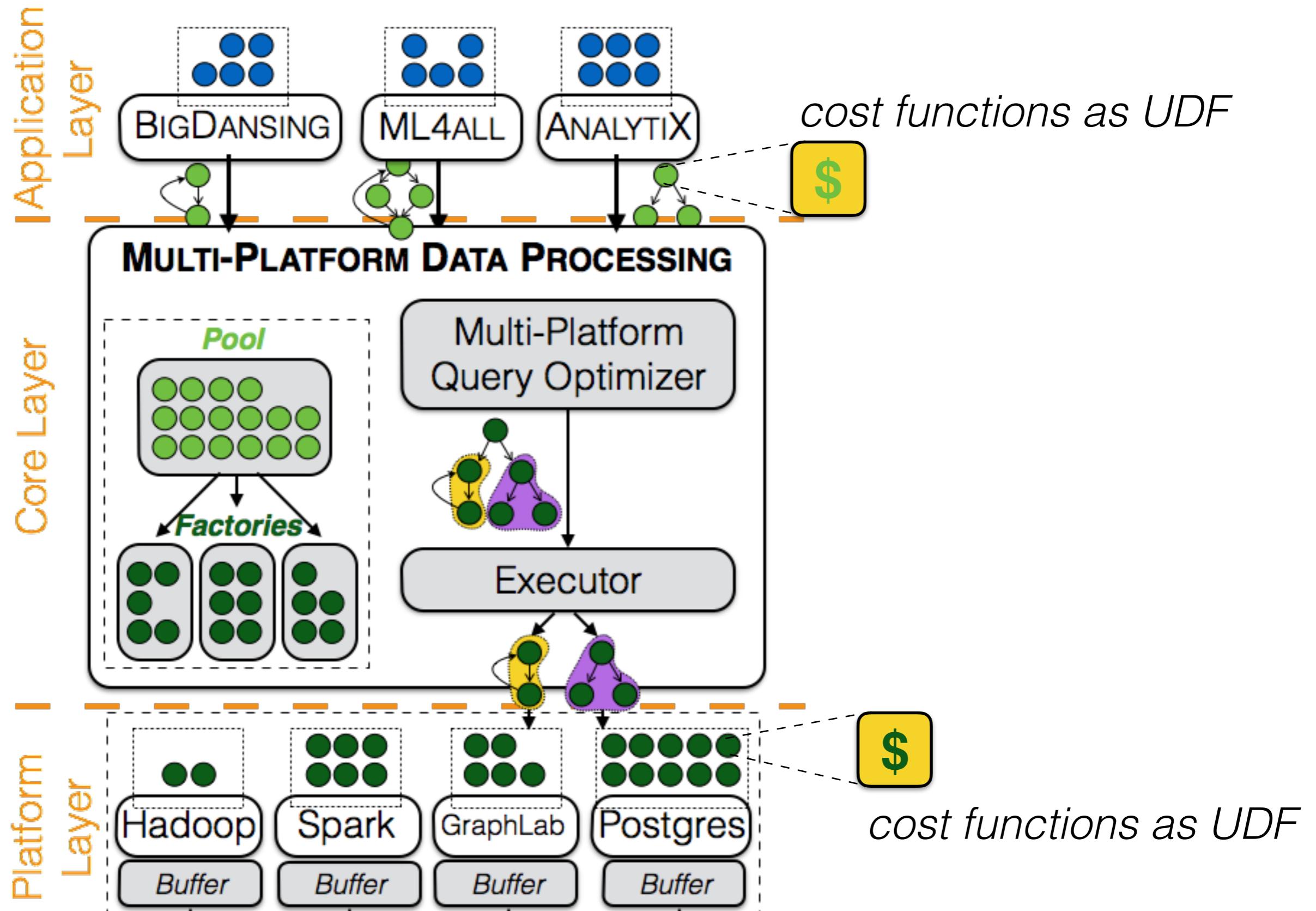
Multi-Layer Optimization



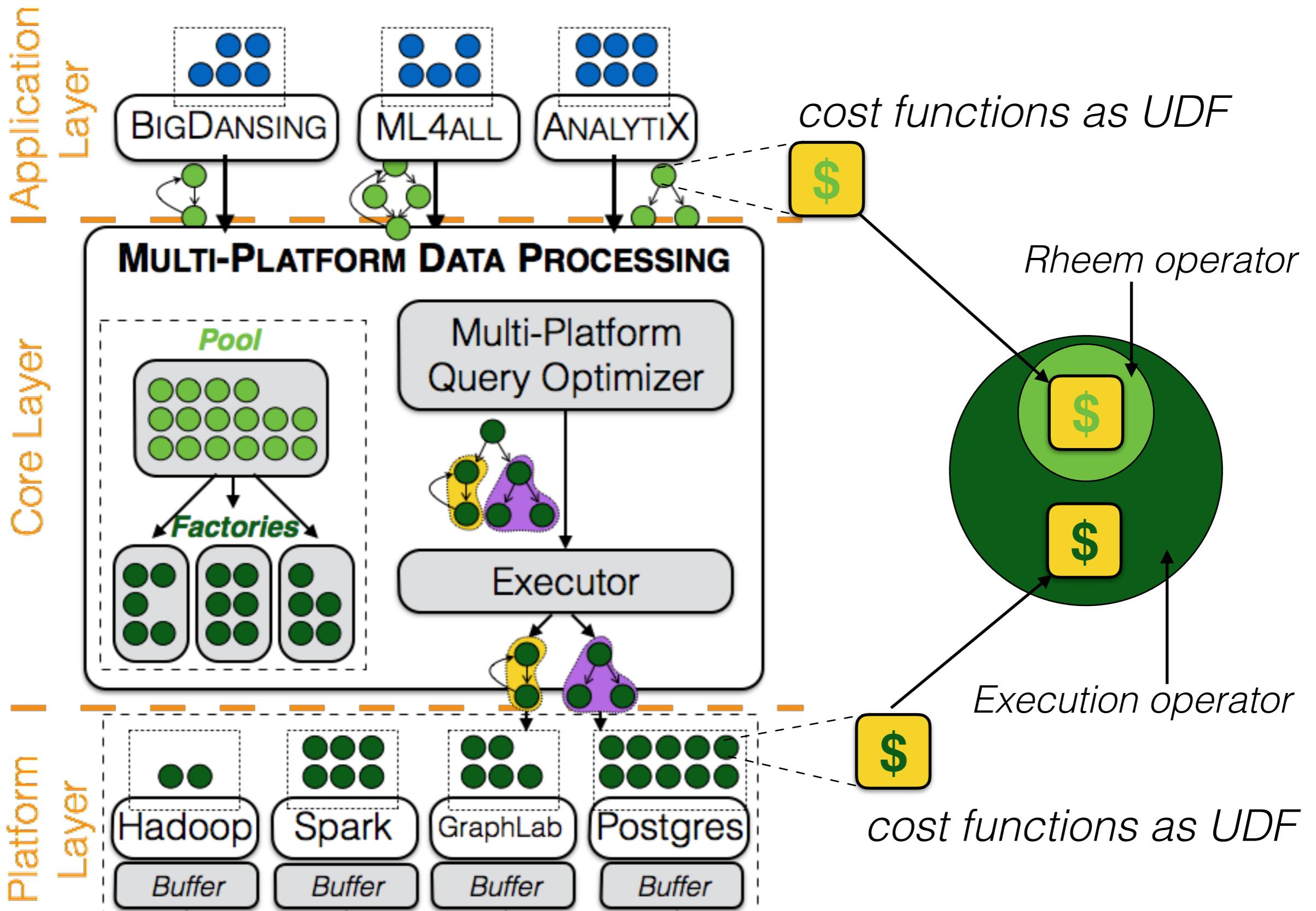
Multi-Layer Optimization



UDF-based Cost Model

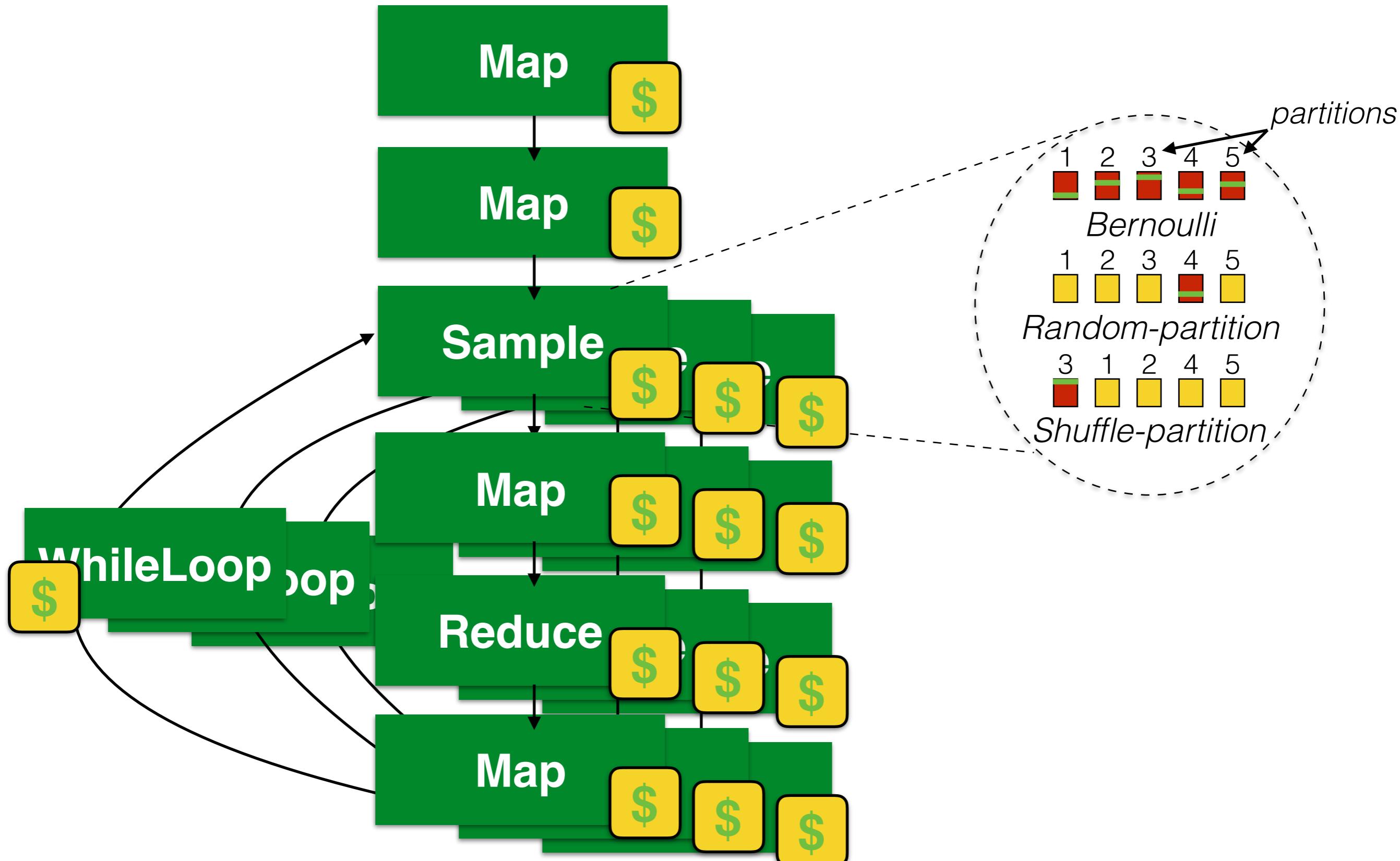


UDF-based Cost Model



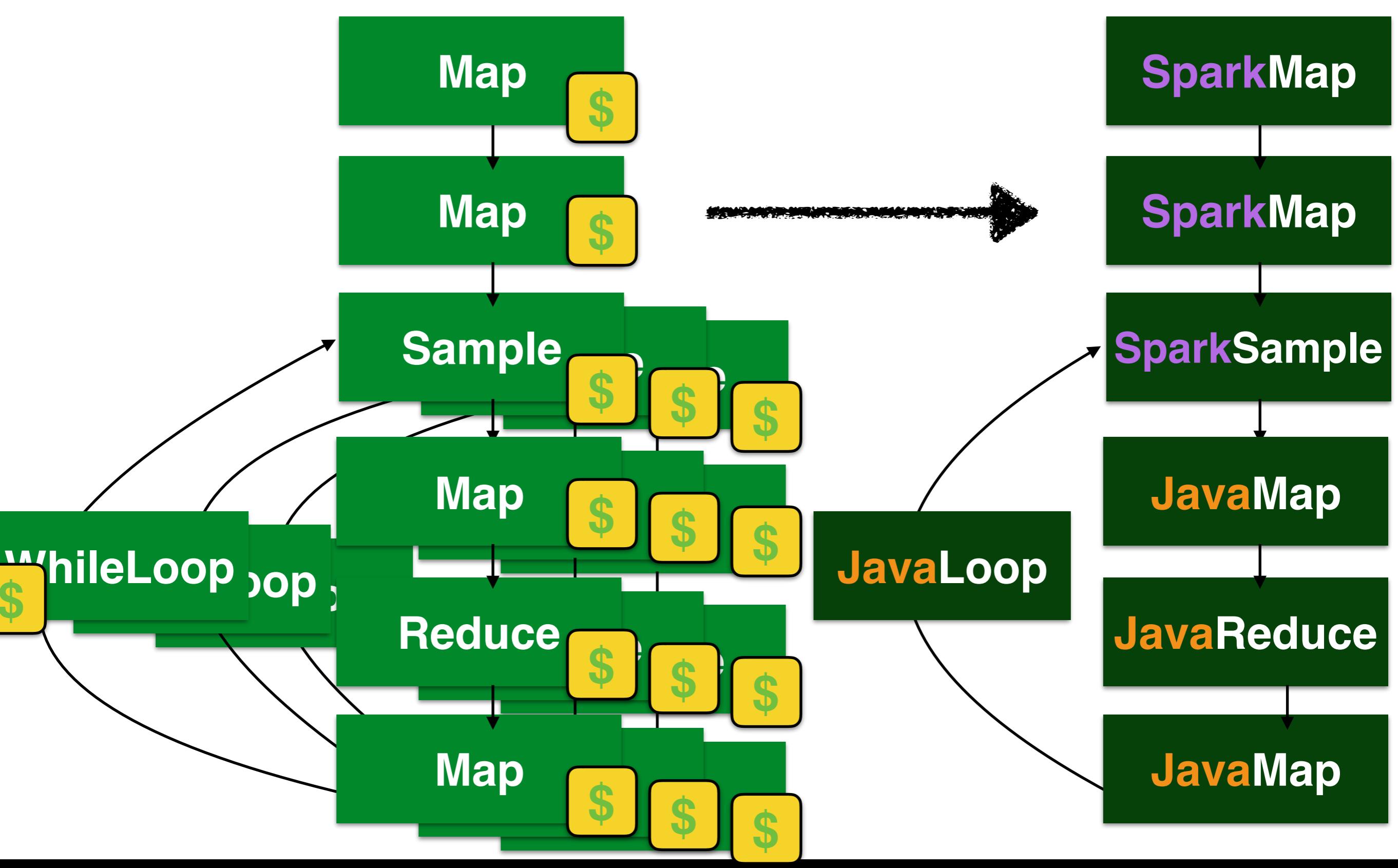
UDF-based Cost Model

Problem 3: Learning Cost Functions?

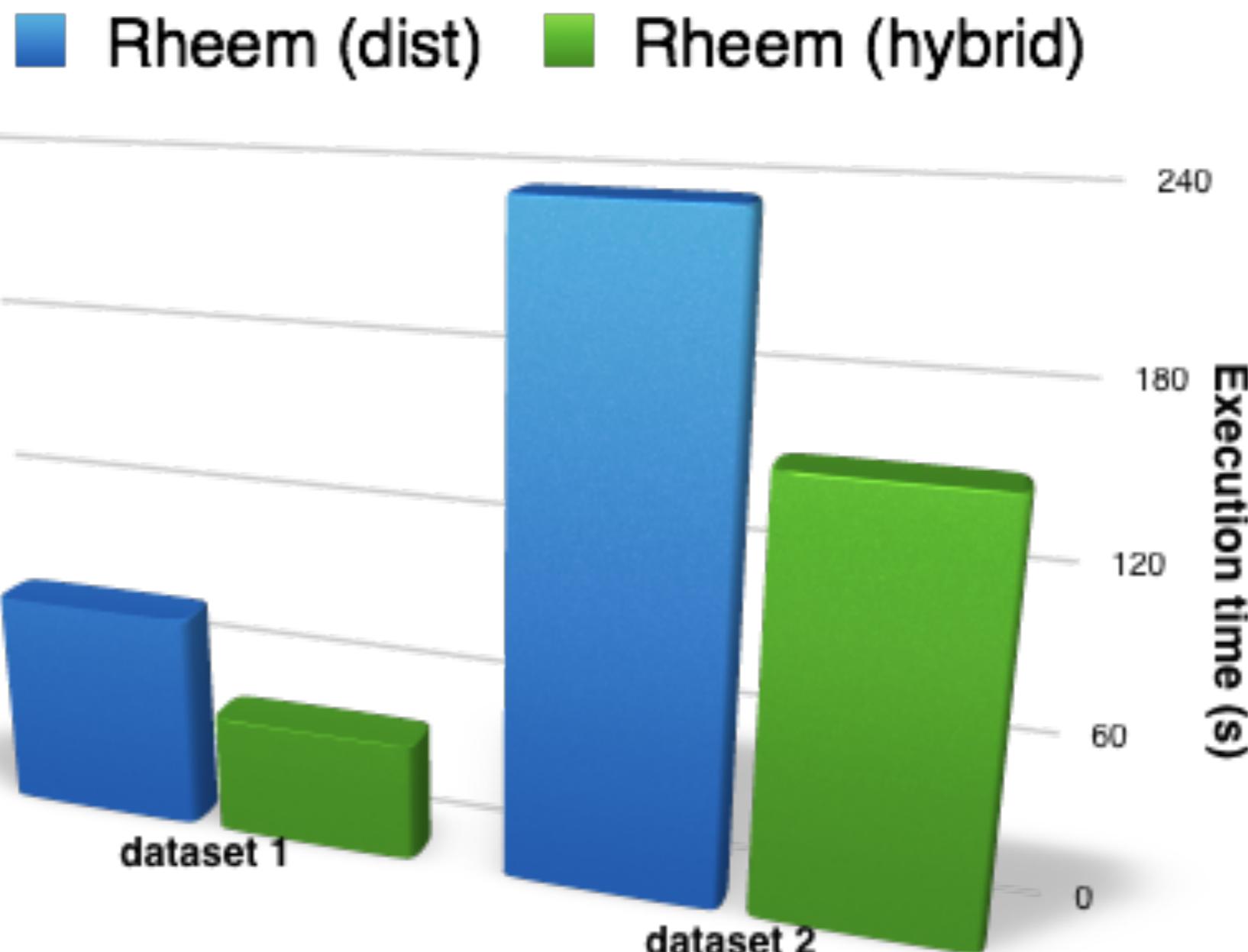


RHEEM HyperPlans

Problem 4:
Data
Transformation
and Shipping?



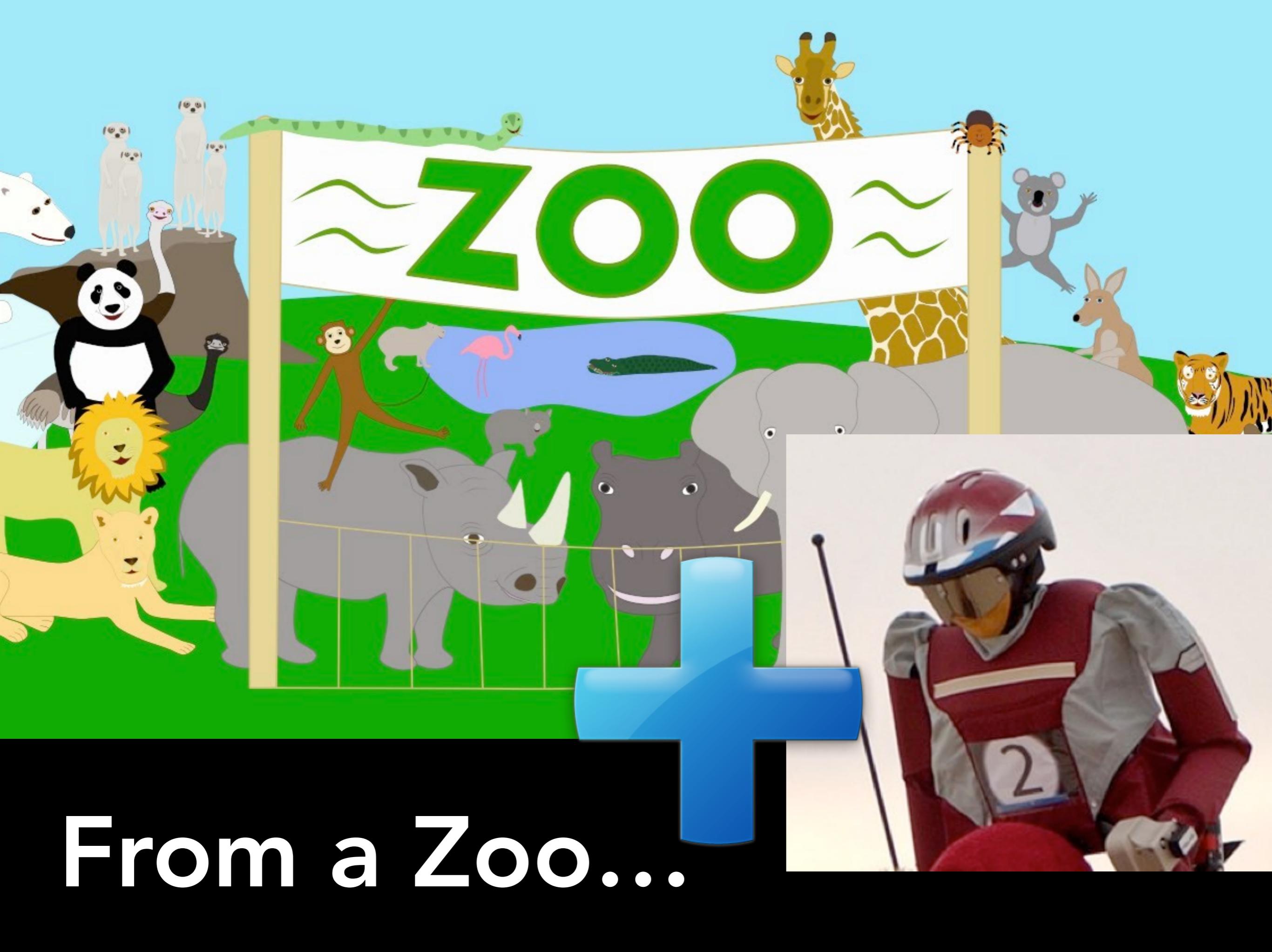
RHEEM Plan → **Execution Plan**



RHEEM Fully Distributed vs. RHEEM Hybrid

SVM on RHEEM

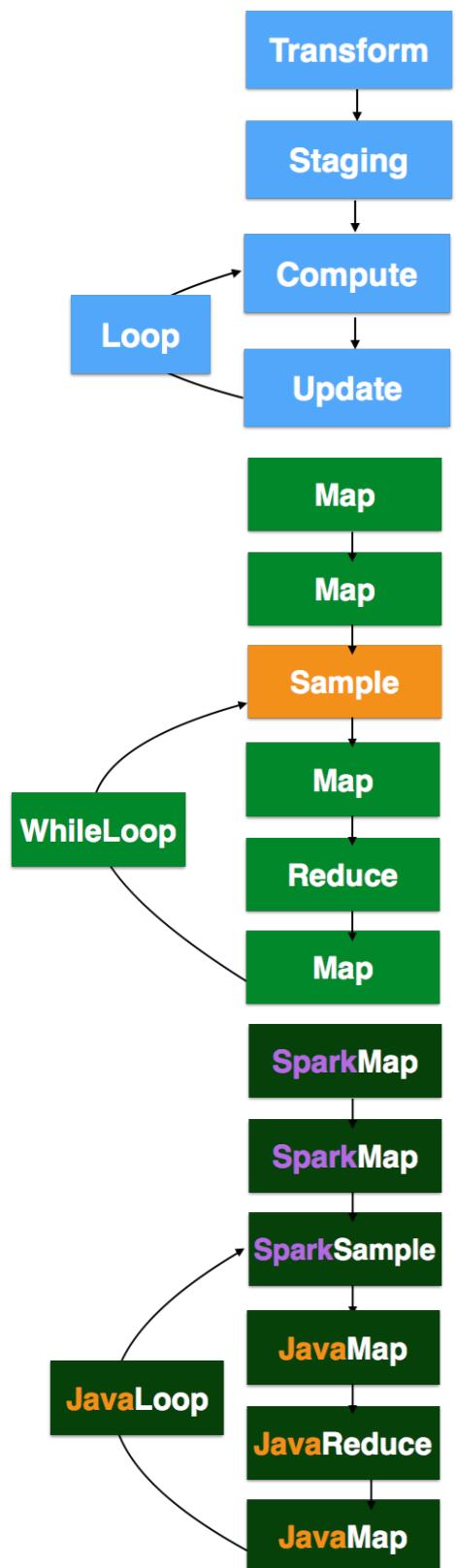
Problem 5: Intermediate Data Sharing?



From a Zoo...



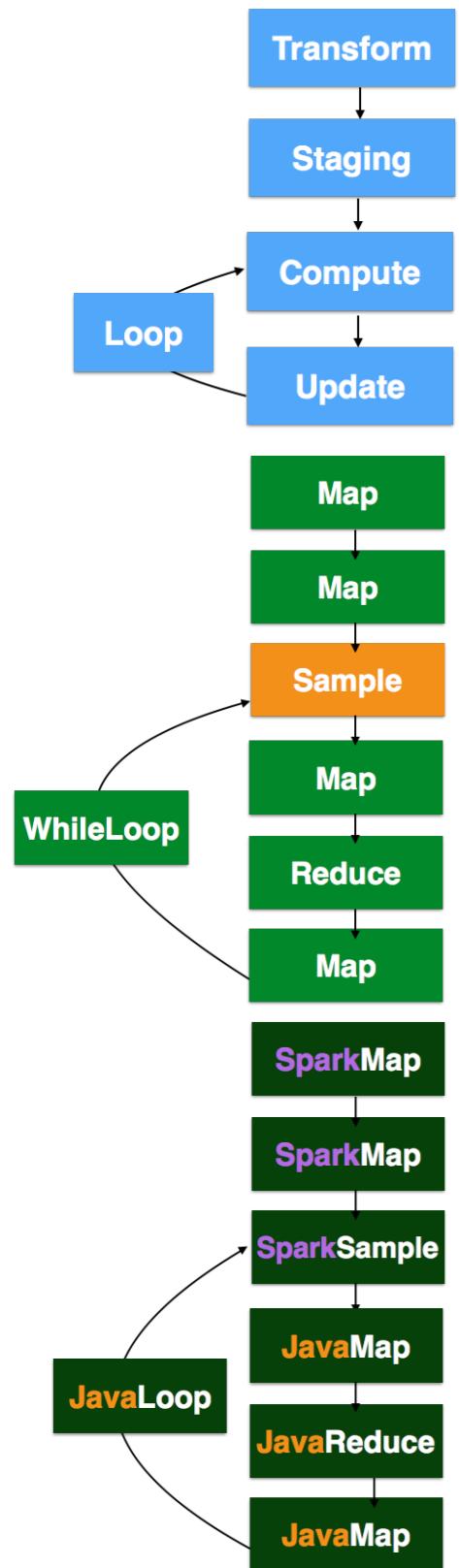
... to a Circus



(1) Abstract an application

(2) Build optimized Rheem plans

Developing on RHEEM



(1) Abstract an application

(a) Profile each operator

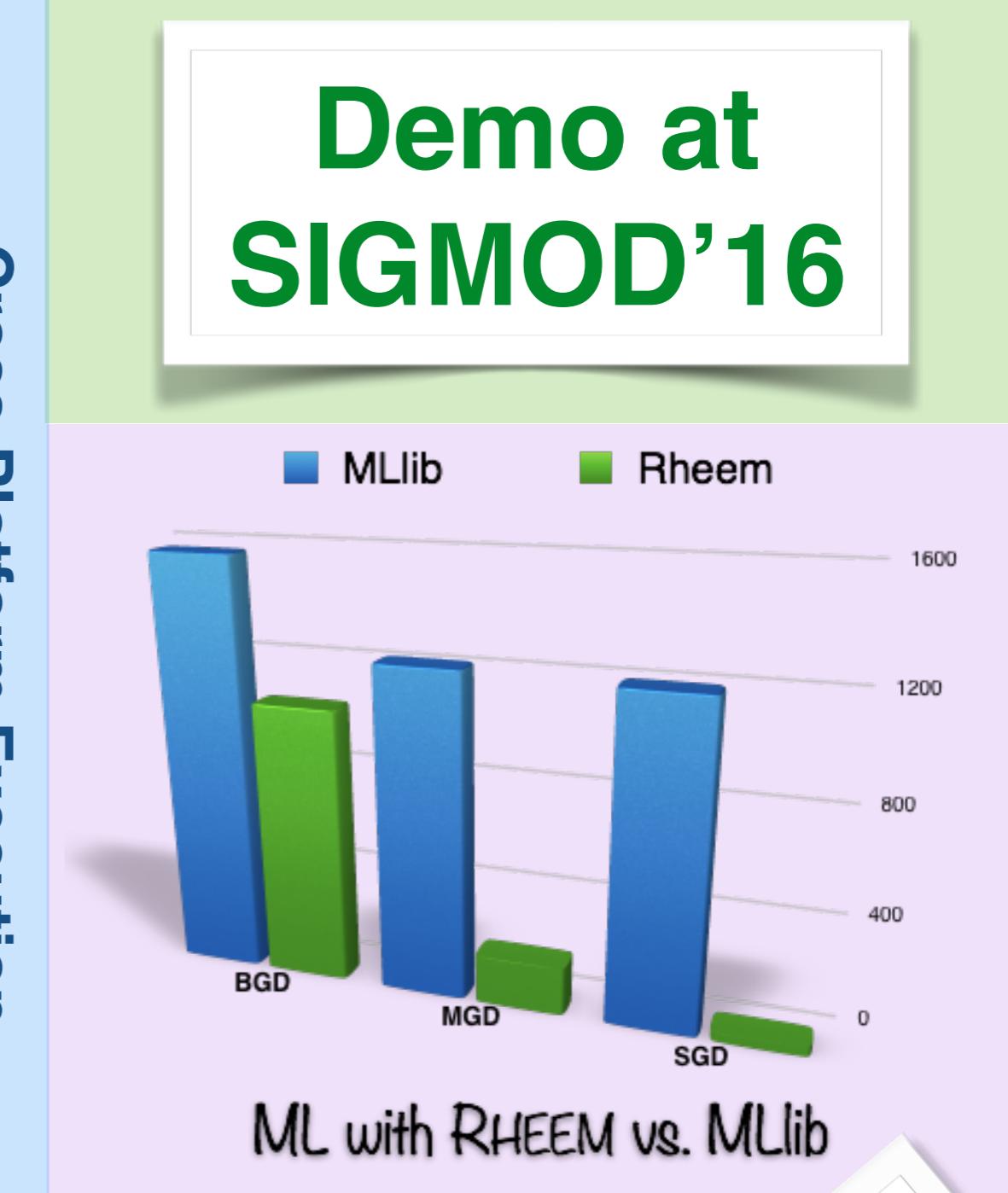
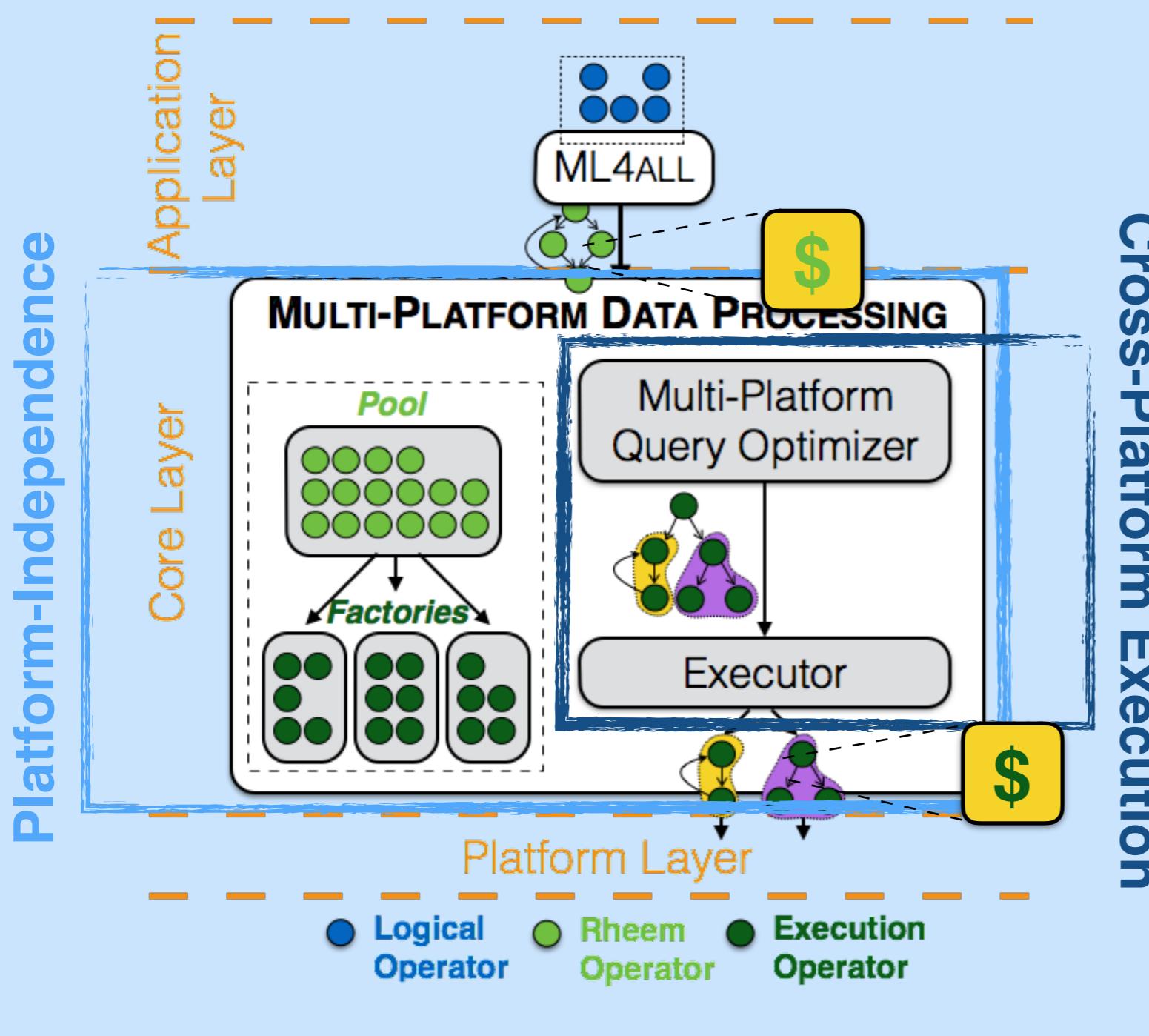
(2) Build optimized Rheem plans

(b) Provide new Rheem Operators
 (-) New UDF with mappings

(c) Introduce your own tricks
 (-) New execution operators
 (-) New mappings

Developing on RHEEM

Demo at SIGMOD'16



Data transformation and shipping model
Cross-Platform Declarative Language
Efficient intermediate data sharing
Progressive Optimization
Learning cost functions

da.qcri.org/rheem/