Apache Flink

When Table meets AI: Build Flink AI Ecosystem on Table API

Jiangjie (Becket) Qin / 秦江杰
Staff Engineer at Alibaba

2019/6/28, Apache Flink Meetup Beijing

Agenda

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- Why TableAPI + AI?
- Build an AI Ecosystem on TableAPI
  - TableAPI enhancement
  - Iteration
  - Machine Learning Pipeline & ML Libs
  - Deep Learning on Flink (TensorFlow, PyTorch)

TableAPI: Declarative API with Optimization

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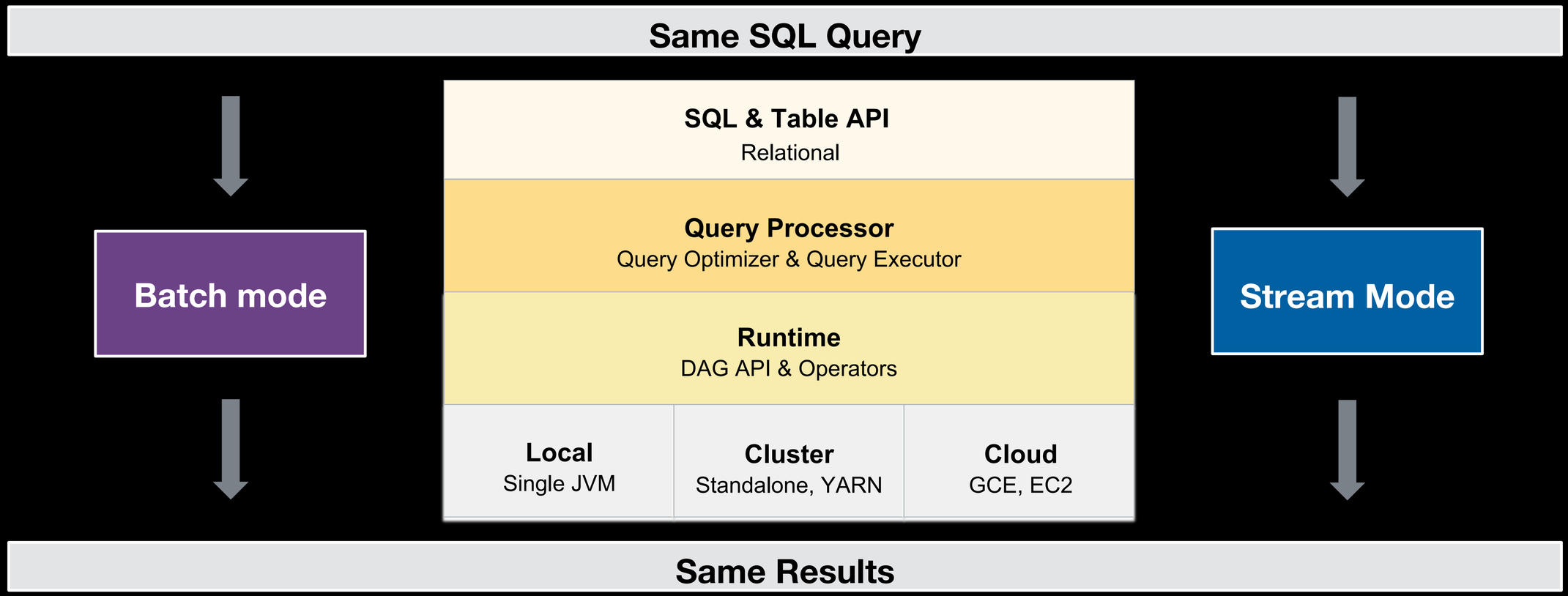

similar as SQL, batch&stream unified, declarative API with nature optimization framework

TableAPI is more than SQL

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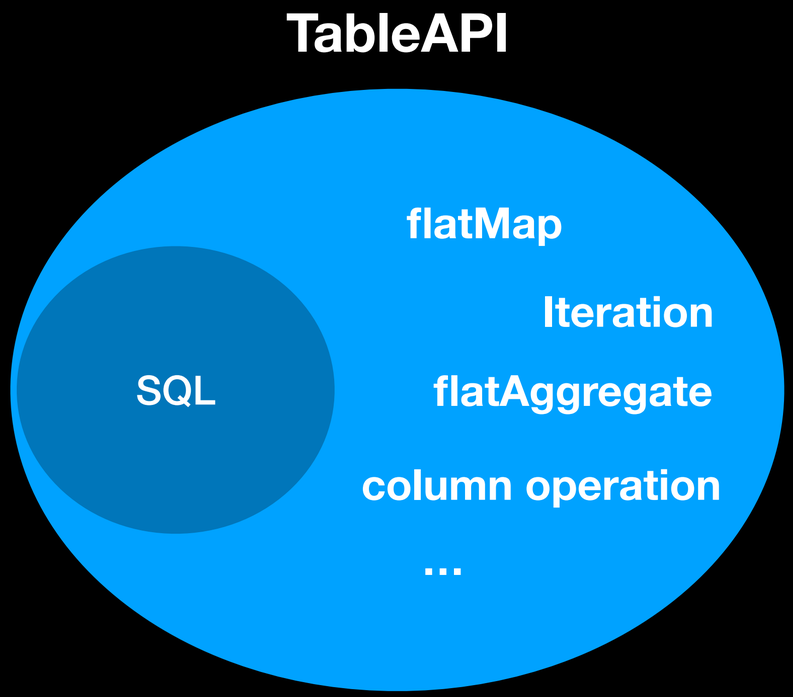
	TableAPI	SQL	e.g.
Stream and batch unified	Y	Y	SELECT/AGG/ WINDOW etc.
Functional scalability	Y	N	flatAgg/ Column operations etc.
Rich expressive	Y	N	map/flatMap/ intersect etc.
Compile check	Y	N	Java/Scala IDE



AI Computing Pipeline

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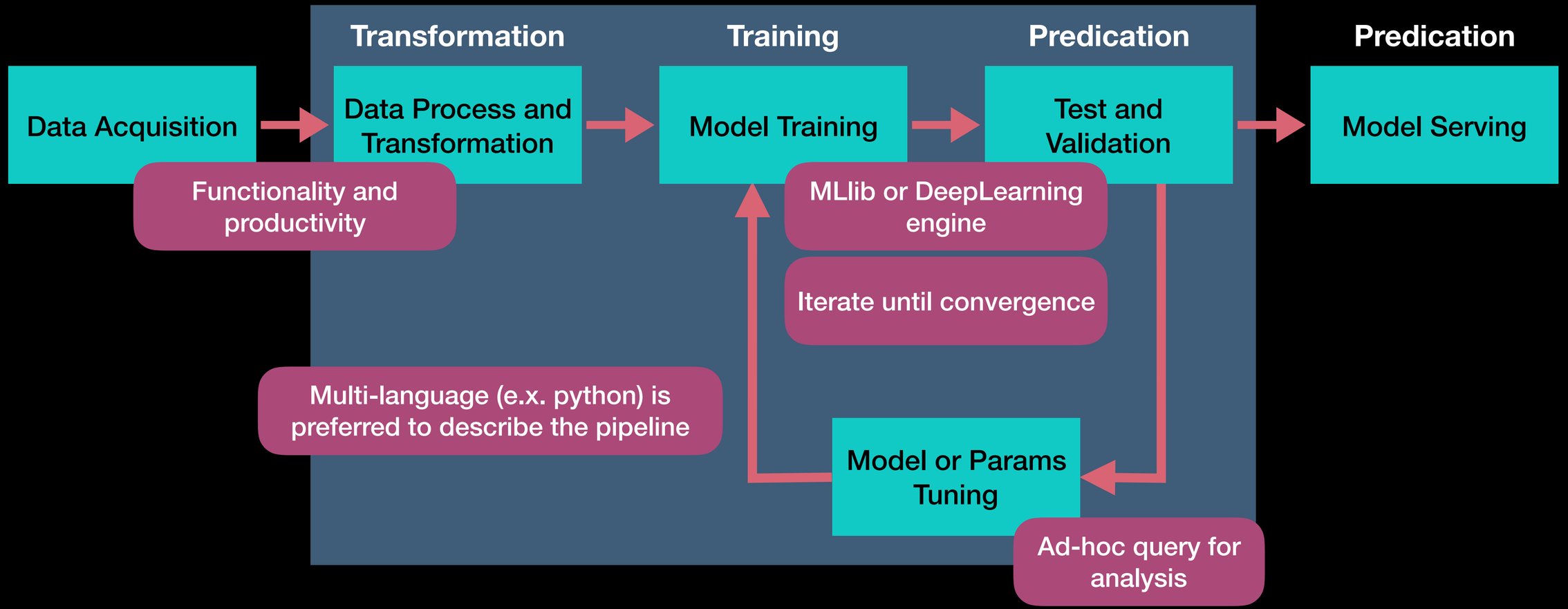

AI Requirements

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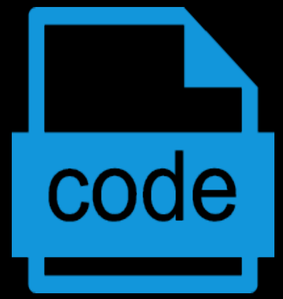
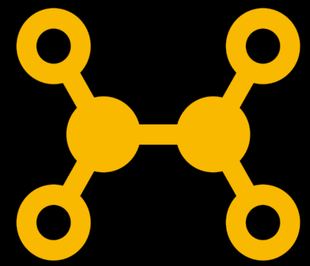
Functionality and Productivity Enhancement

Interactive programming



Multi-language

Iteration



Execute MLlib and DL engine

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Introducing Row-based processing APIs

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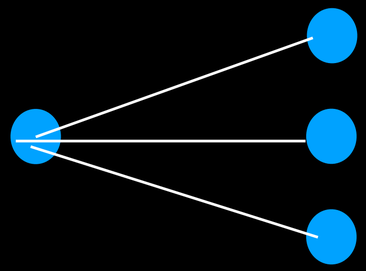
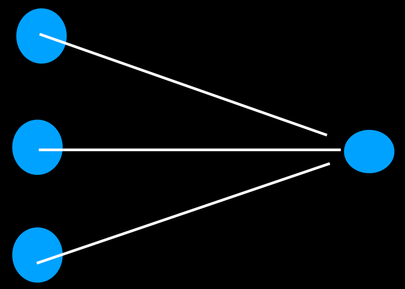
	Single Row Input	Multiple Row Input
Single Row Output	ScalarFunction (select/map)	AggregateFunction (select/aggregate)
Multiple Row Output	TableFunction (cross join/flatmap)	TableAggregateFunction (flatAggregate)

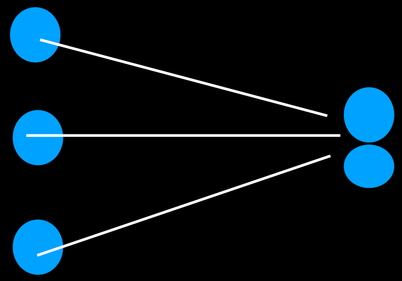
ScalarFunction
(select/map)



TableFunction
(cross join/flatmap)



AggregateFunction
(select/aggregate)



TableAggregateFunction
(flatAggregate)

Introducing Table.cache() for Interactive Programmi

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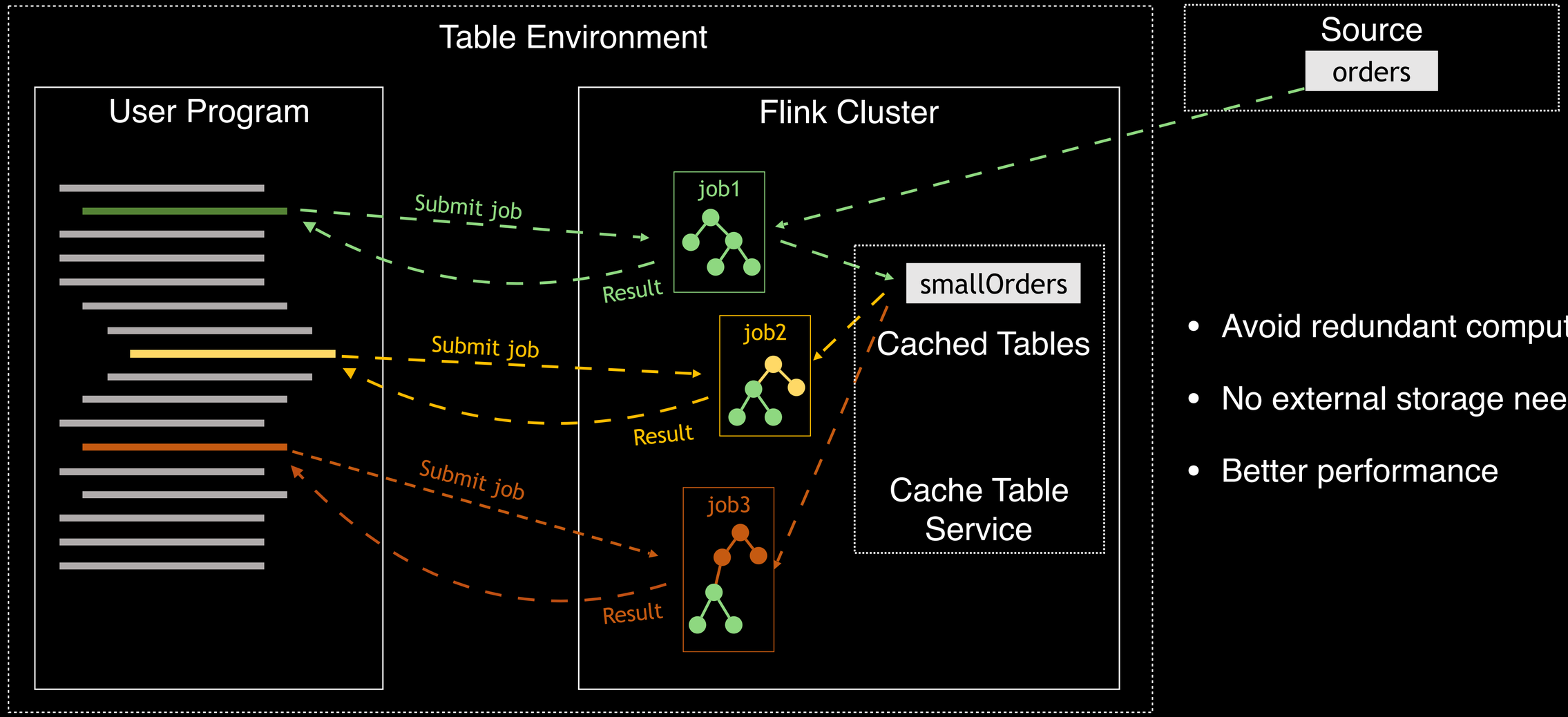

- Avoid redundant computation
- No external storage needed
- Better performance

Flink Python TableAPI

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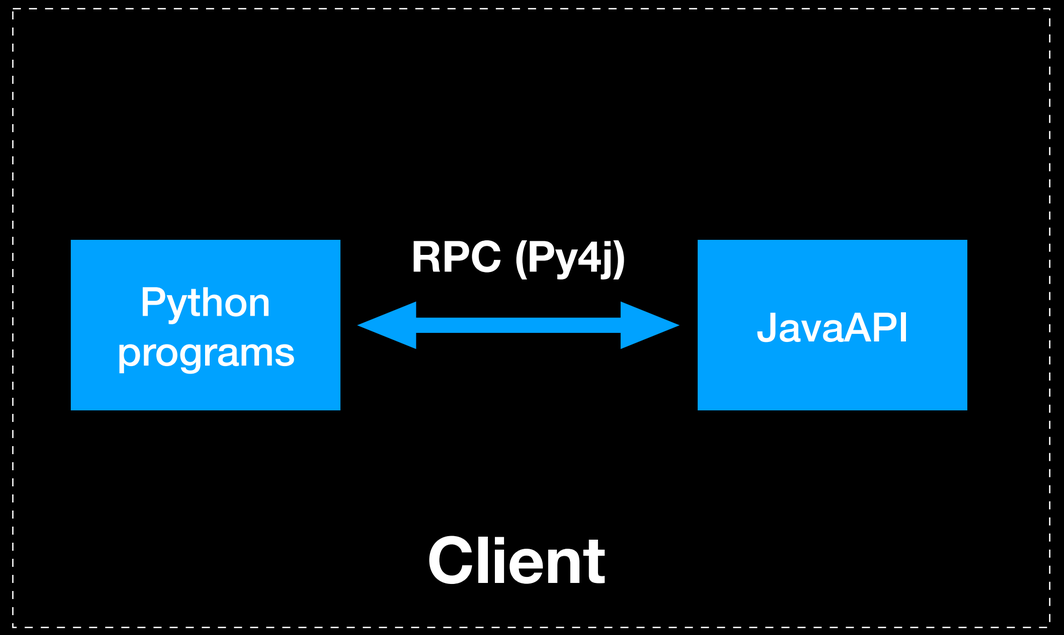
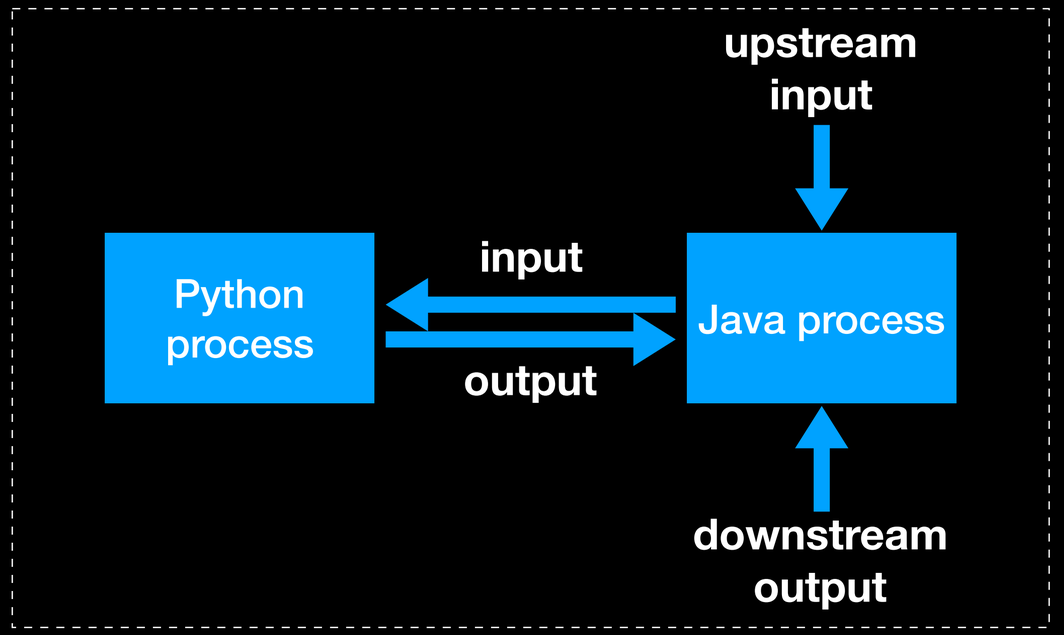
Python TableAPI



Python UDF



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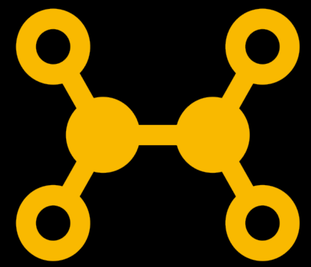
Iteration



Execute MLlib and DL engine

Iteration

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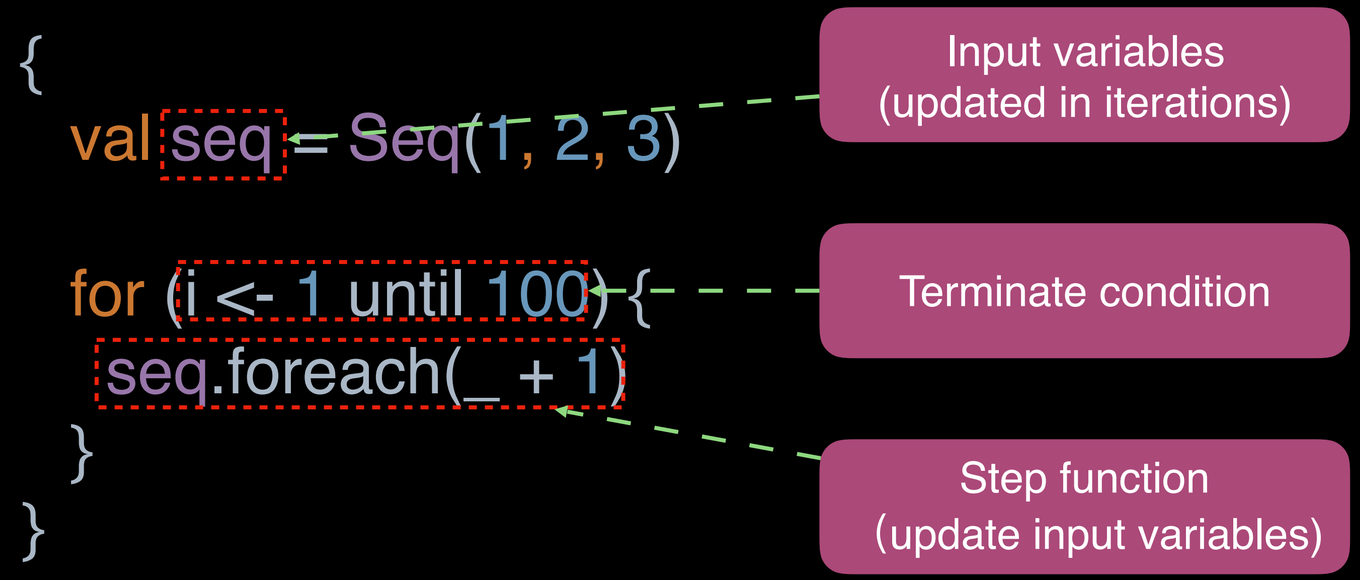
- Execute same processing logic repeatedly
- Input of each round is the output of the previous round



Two ways of doing iteration

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Without any new API:

Leveraging interactive programming

With a new tableAPI:

Introducing table.iterate()

Approach 1: Iteration with interactive programming

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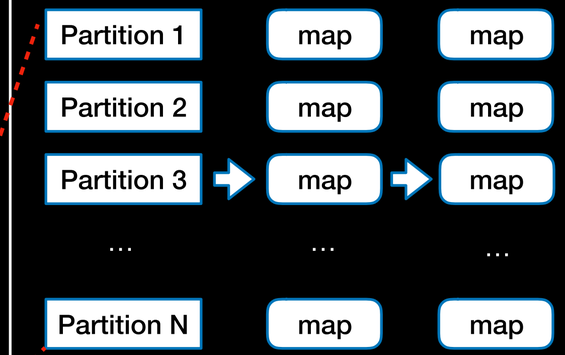
User Program

```
{
  val NUM_ITERATIONS = 100
  var parameters = …
  val samples = ...

  for (i <- 1 until NUM_ITERATIONS) {
    val gradients = samples.map(sample => computeGradients(sample))
    parameters = gradients.map(grad => updateParameters(grad)).collect()
  }
}
```

Flink Cluster



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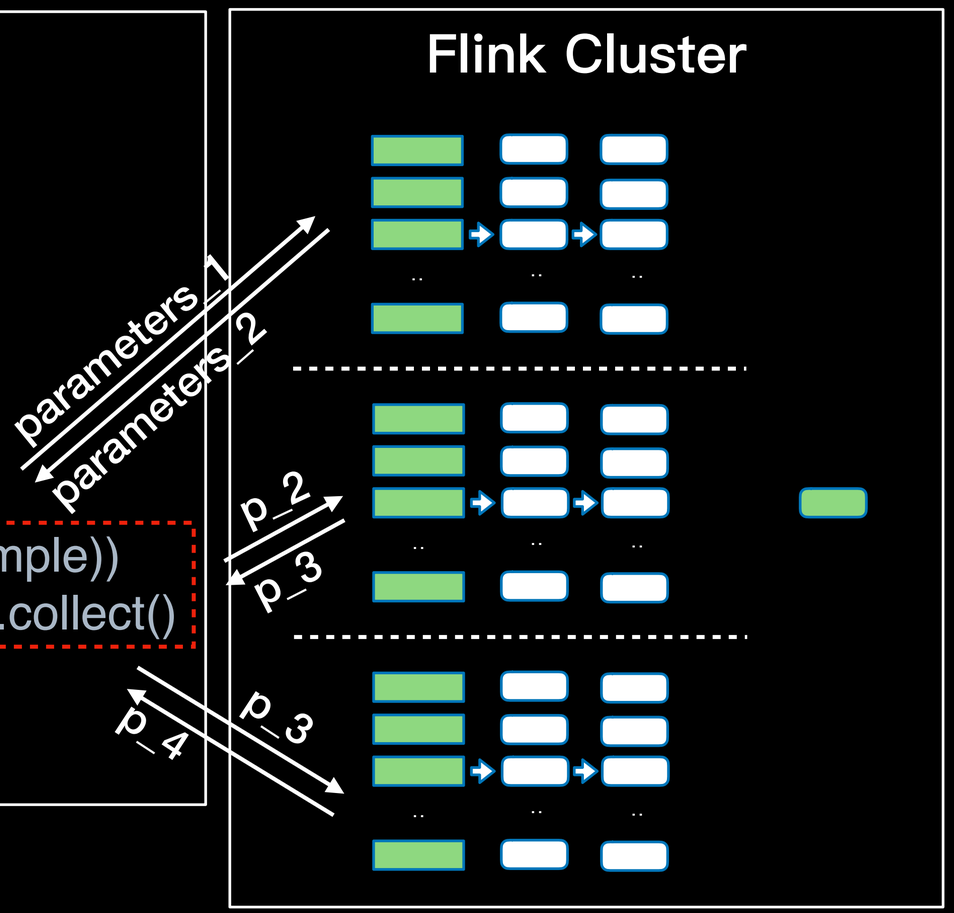


Parameters are updated through repeated serialization

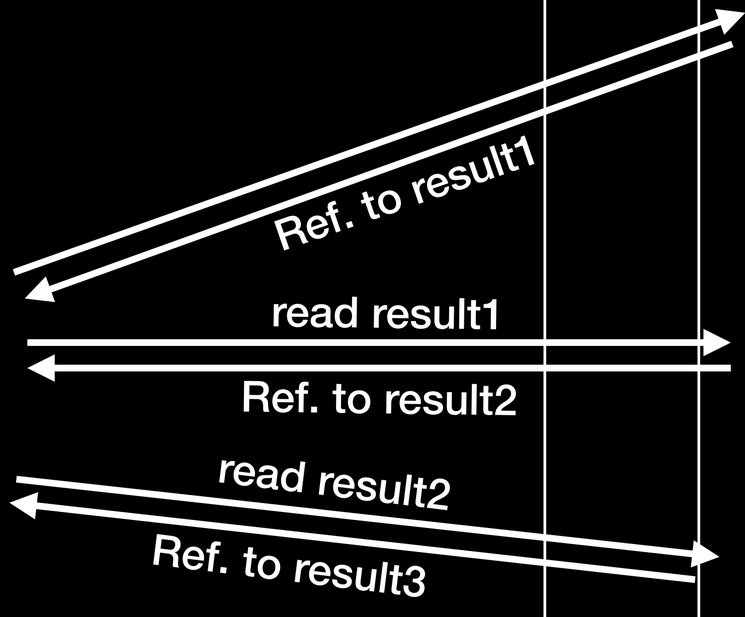
Approach 1: Iteration with interactive programming

Apache Flink

User Program

```
{
  var t = tEnv.fromCollection(data).as ('f1)
  var count = t.select(‘f1.count).collect().size

  while (count > 0) {
    newT = t.select('f1 + 10).filter('f1 < 1000)
    newT.cache()
    count = t.select(‘f1.count).collect().size
    t = newT
    t.uncache()
  }
}
```



Flink Cluster

Variables updated with cached result from last round

Approach 1: Iteration with interactive programming

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- logic of iteration is implemented by the users
- **have to** submit a job for each round of iteration
- have to manage the lifecycle of the cached tables

Pros	Cons
Simple and intuitive	Overhead of job submission
Good flexibility in code logic	Synchronization after each round

Approach 2: Introducing Iterate on TableAPI

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- Native iteration implemented by the processing engine
- Feedback edge on the processing DAG
- Improve the caveats in DataSet and DataStream iterations
  - **Support multi-variable iteration**
  - **Support nested iteration**

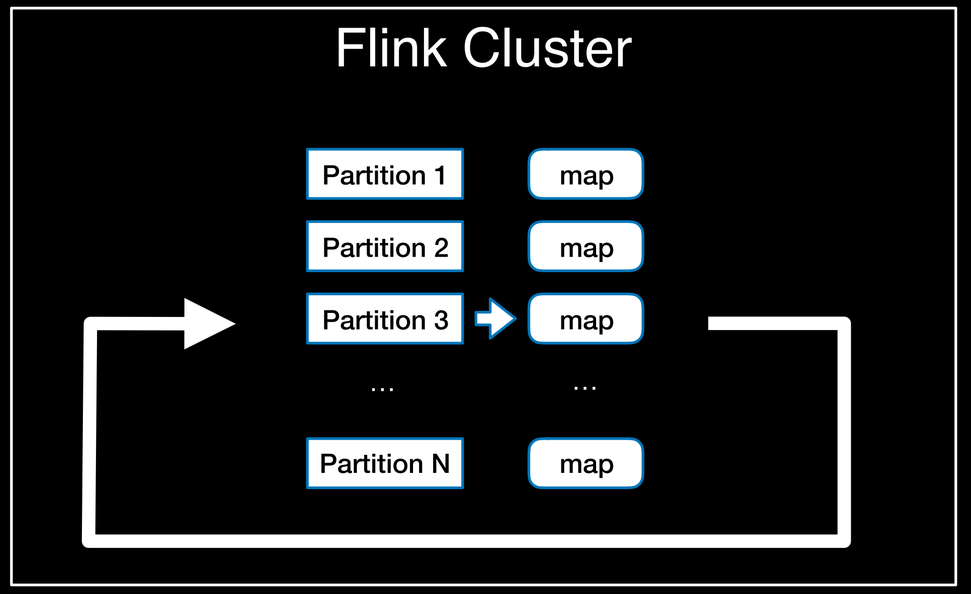

Table.iterate

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```
{
  val a: Table = ...
  val b: Table = ...
  val resultSeq = Table.iterate(a, b) {

    val next_a = b.select('v_b + 1 as 'v_a)

    val next_b = next_a.select('v_a * 2 as 'v_b)

    Seq(next_a, next_b)

  }.times(10)
}
```

Iteration variables

Step function

Termination condition

Table.iterate - Nested Iterations

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```
{
  val a: Table = ...
  val b: Table = ...
  val resultSeq = iterate(a, b) {

    val next_a = iterate(a) {

      Seq(a.select(‘v_a + 1 as 'v_a))

    }.times(100).head

    val next_b = next_a.select('v_a * 2 as 'v_b)

    Seq(next_a, next_b)

  }.times(10)
}
```

Table.iterate - Future Plan

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- About to contribute to Apache Flink
- Future Work
  - Native Support for SGD
  - Native Support for Online Learning Scenarios

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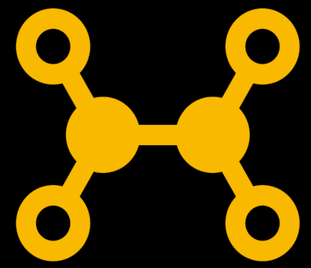
Iteration



Execute MLlib and DL engine

ML Pipeline - Overview

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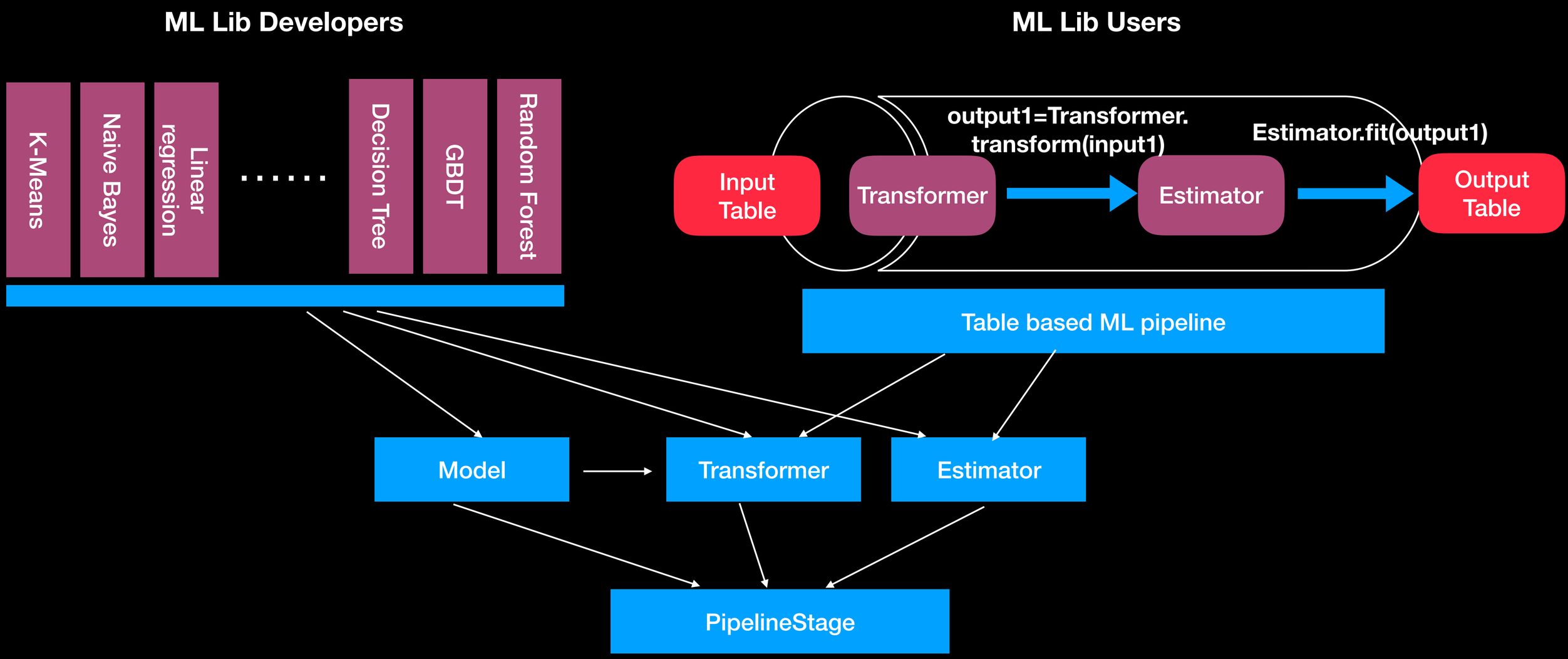

MLlibs

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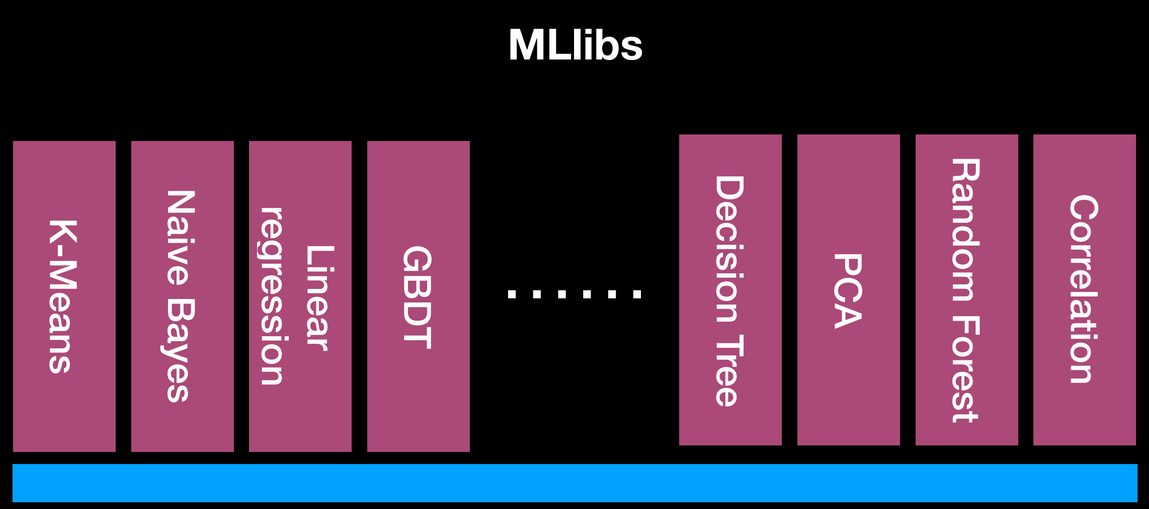

Rewrite Flink ML Libs

- ML pipeline based
- Table API based
- Battle tested algorithm

ML Pipeline - Simple Case

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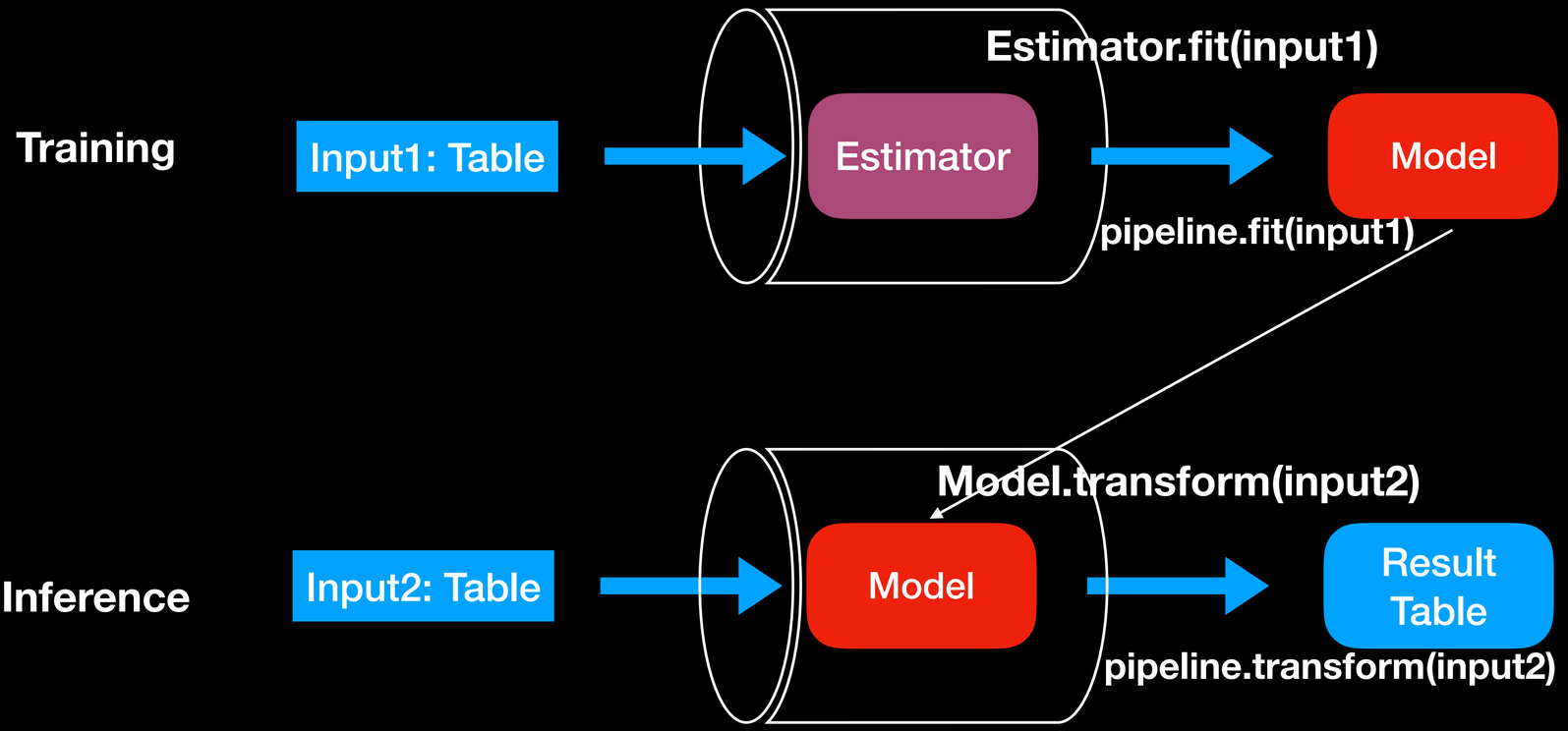
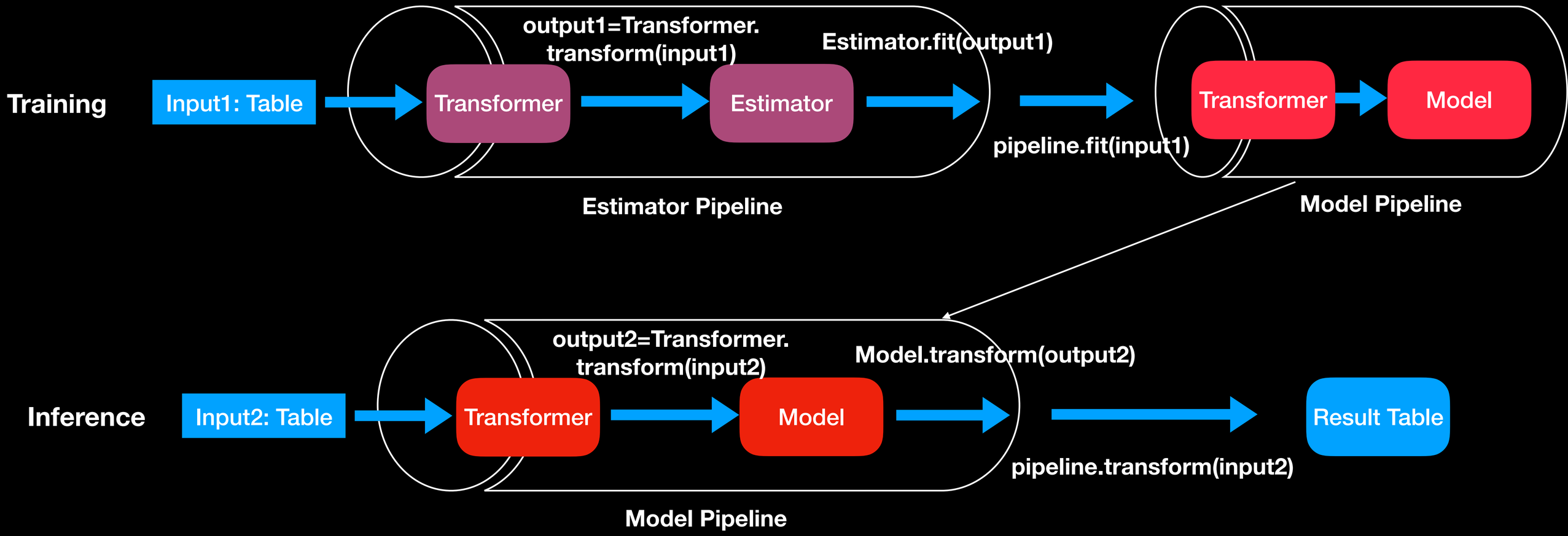


ML Pipeline

Apache Flink



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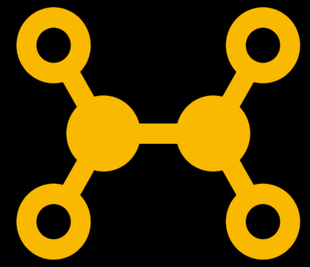
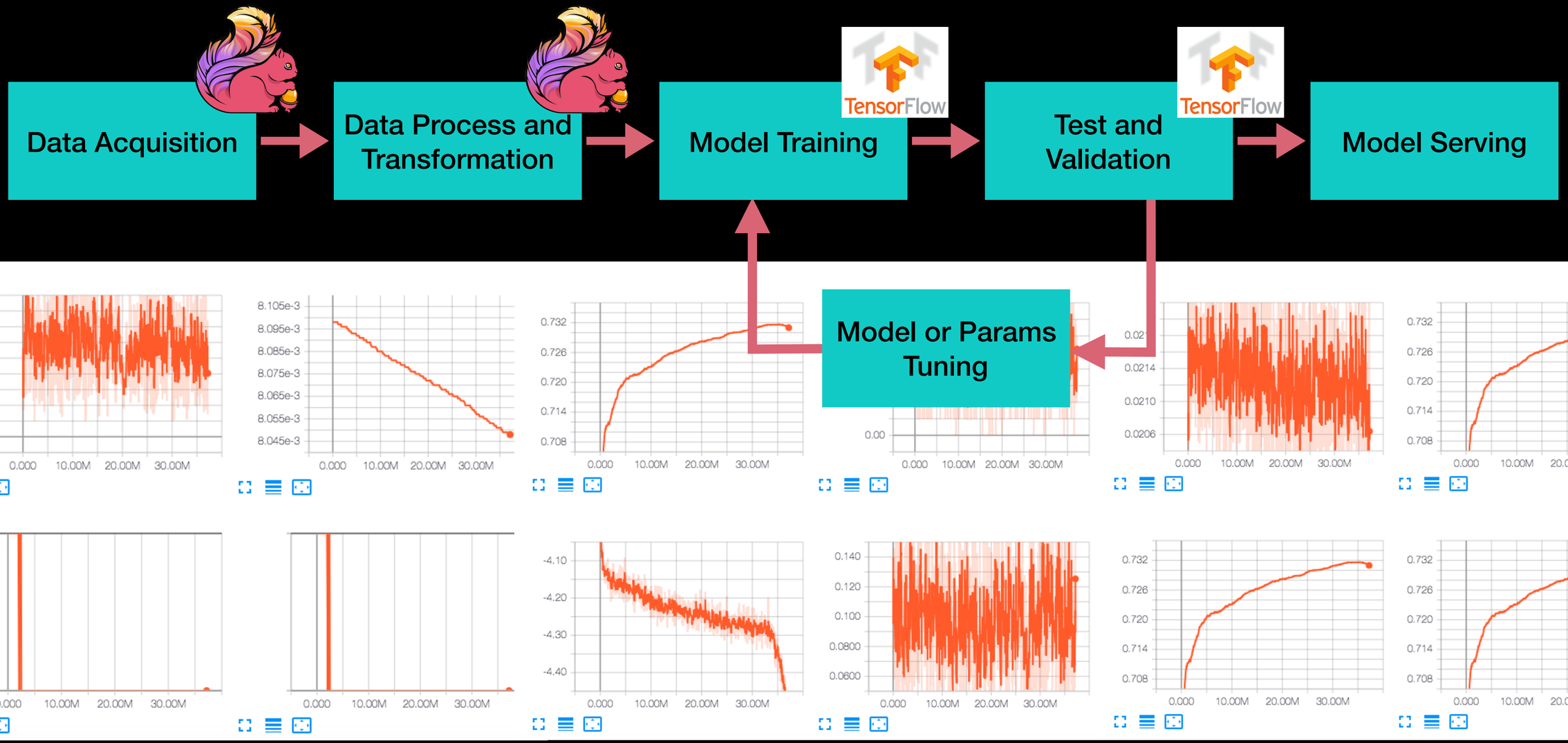


Execute MLlib and DL engine

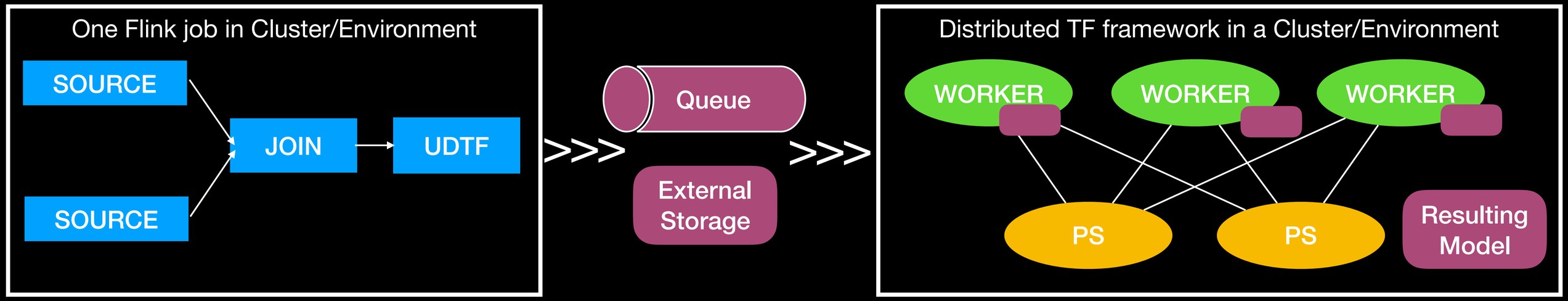
Deep Learning Pipeline

Apache Flink



Deep Learning Pipeline

Apache Flink



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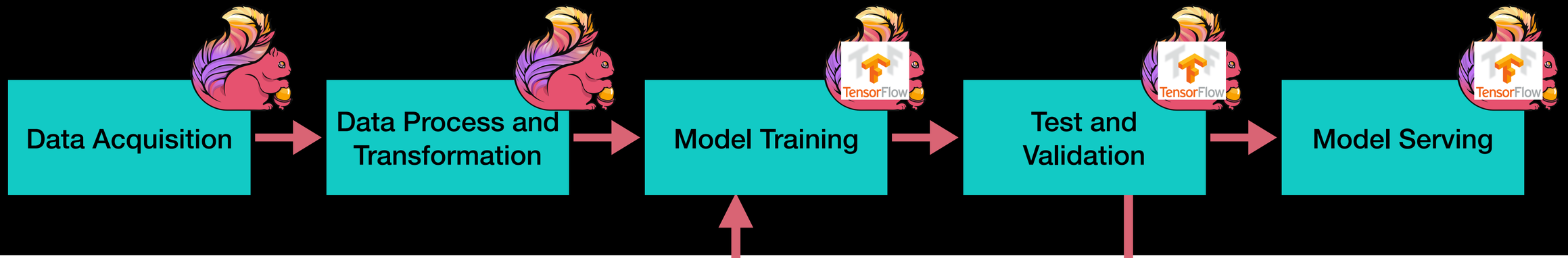

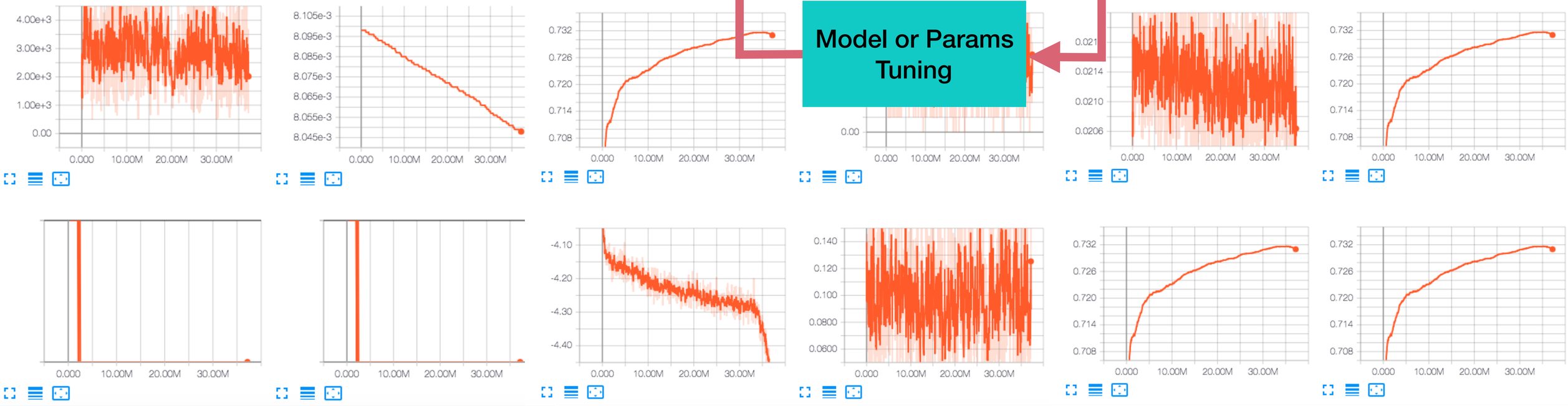

TensorFlow-Flink Integration

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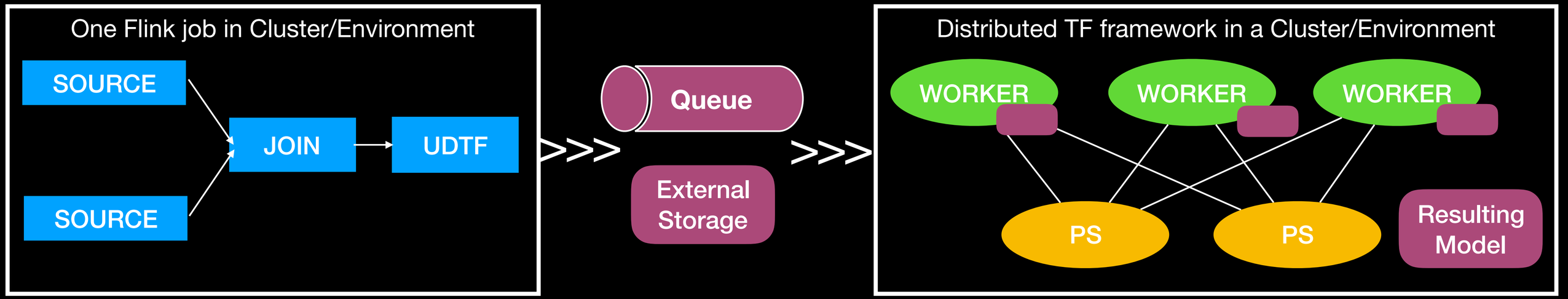

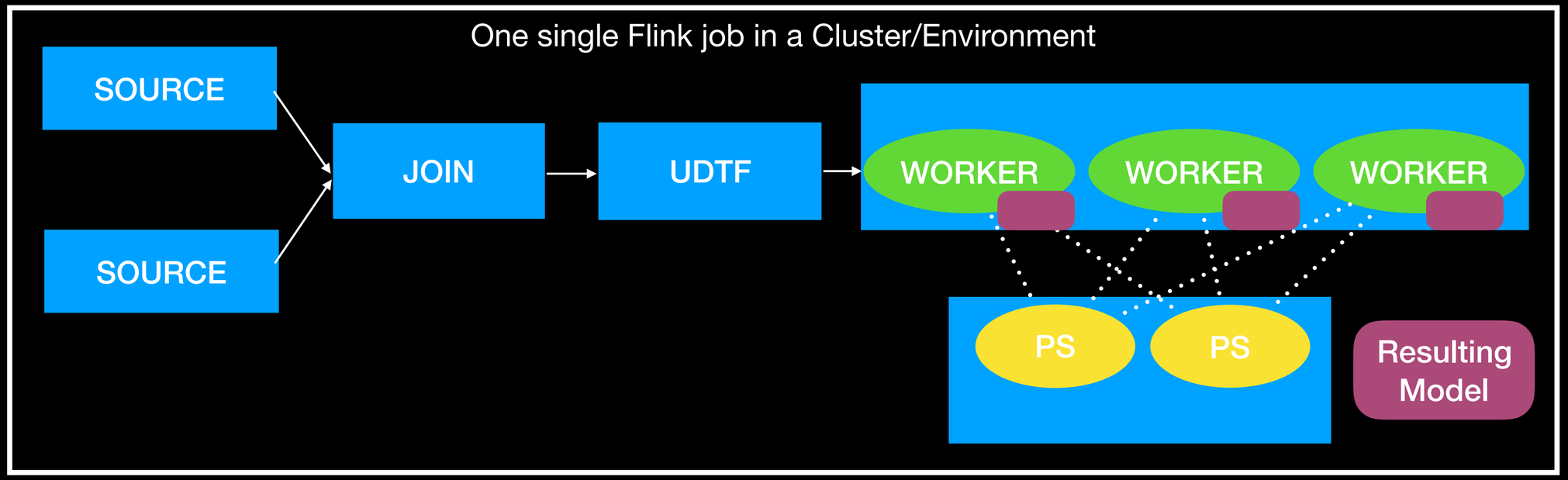

Summary

Apache Flink

- Why Table API + AI?
- Build an AI Ecosystem
  - TableAPI enhancement (FLIP29 etc.)
  - Iteration (Will contribute to Flink)
  - Machine Learning Pipeline & ML Libs (Flink1.9, FLIP-39)
  - Deep Learning on Flink (TensorFlow, PyTorch) (Will open source soon)

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THANKS
Q & A