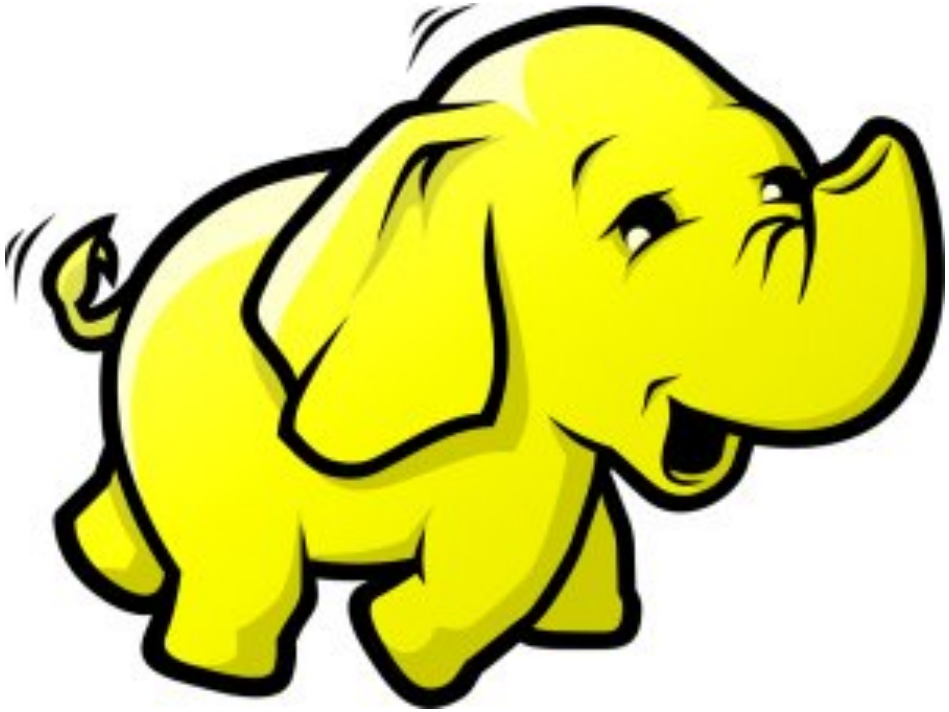
From MapReduce to Spark with Apache Crunch

Micah Whitacre
@mkwhit



Invested in learning

Invested in learning

Setup production clusters

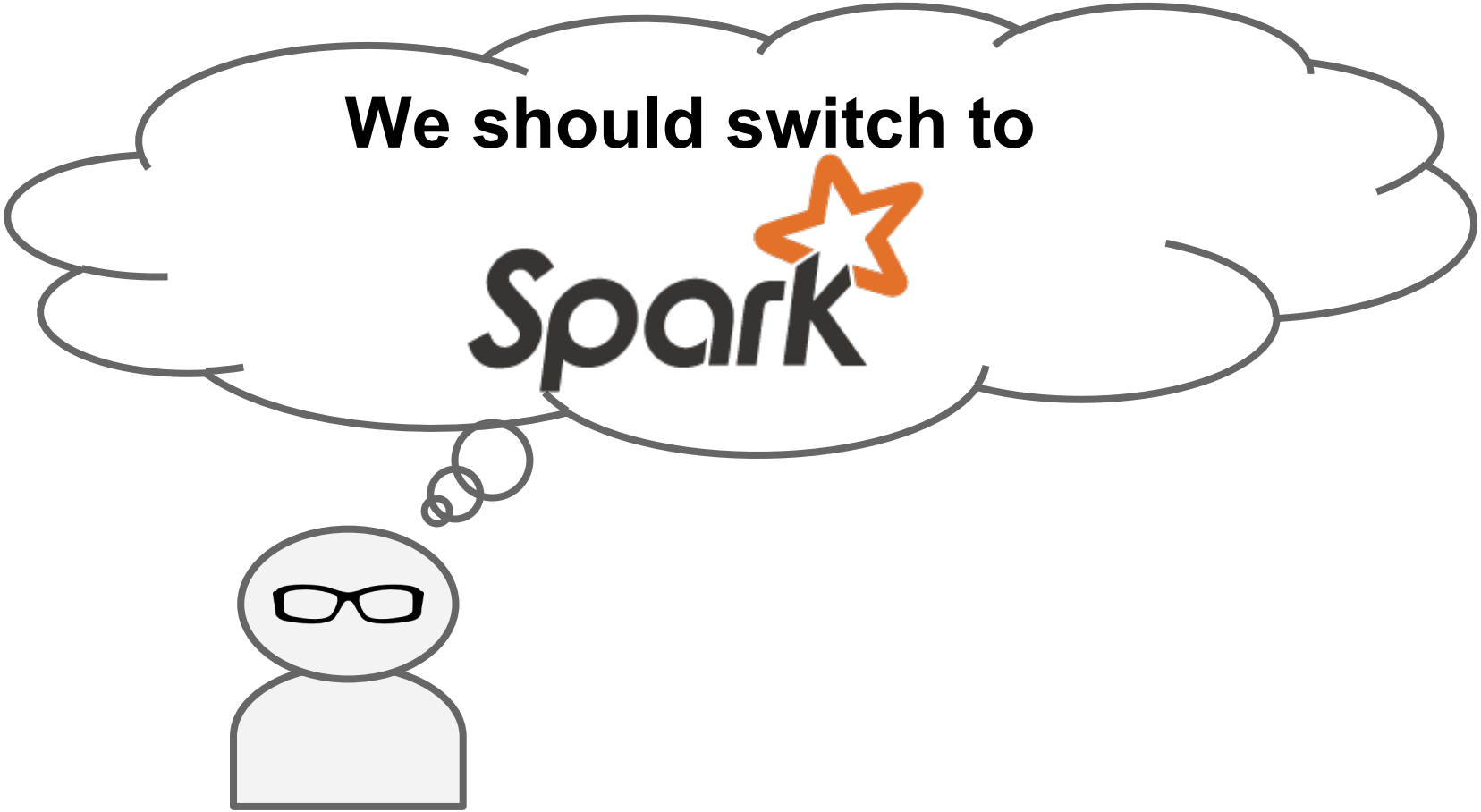
Invested in learning

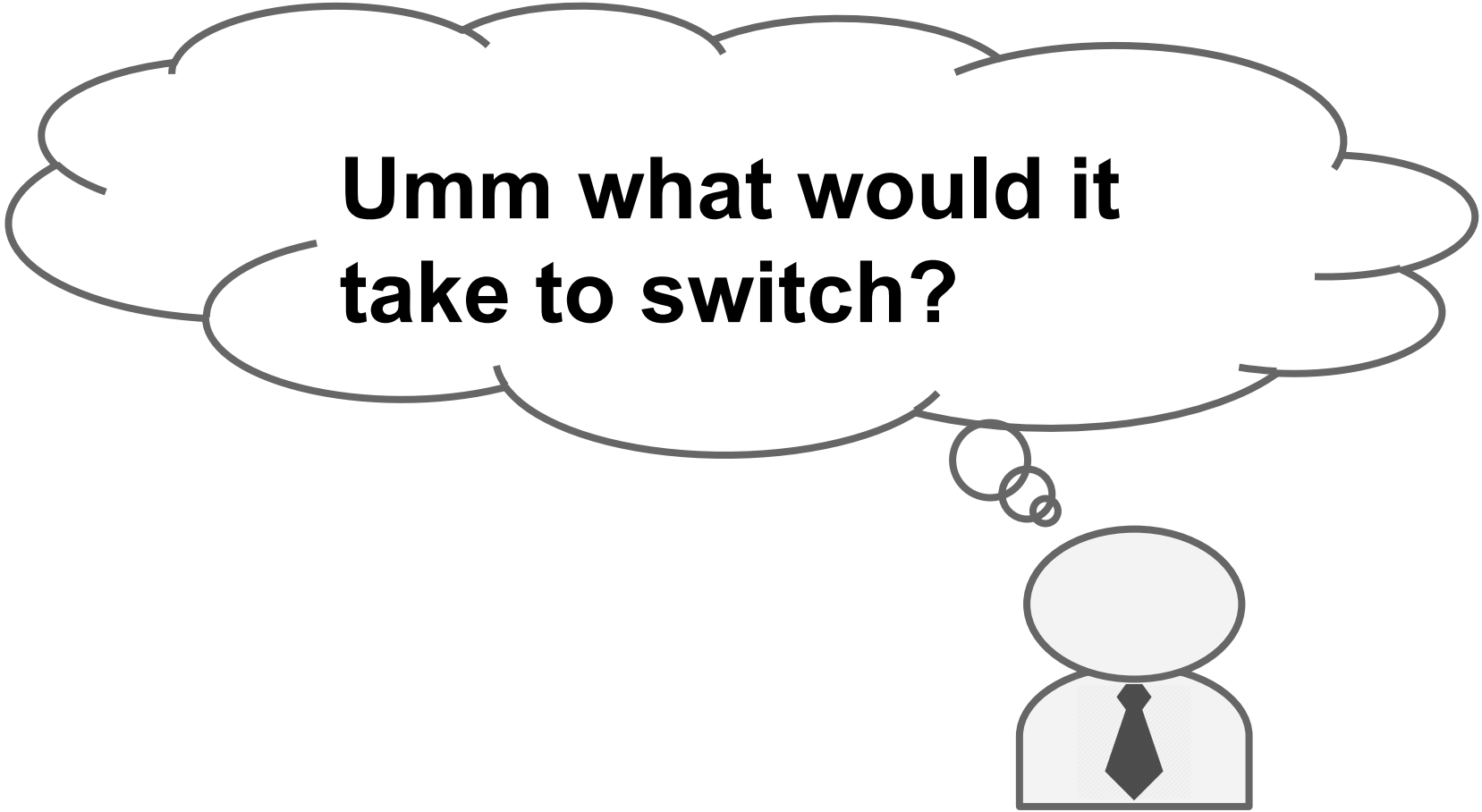
Setup production clusters

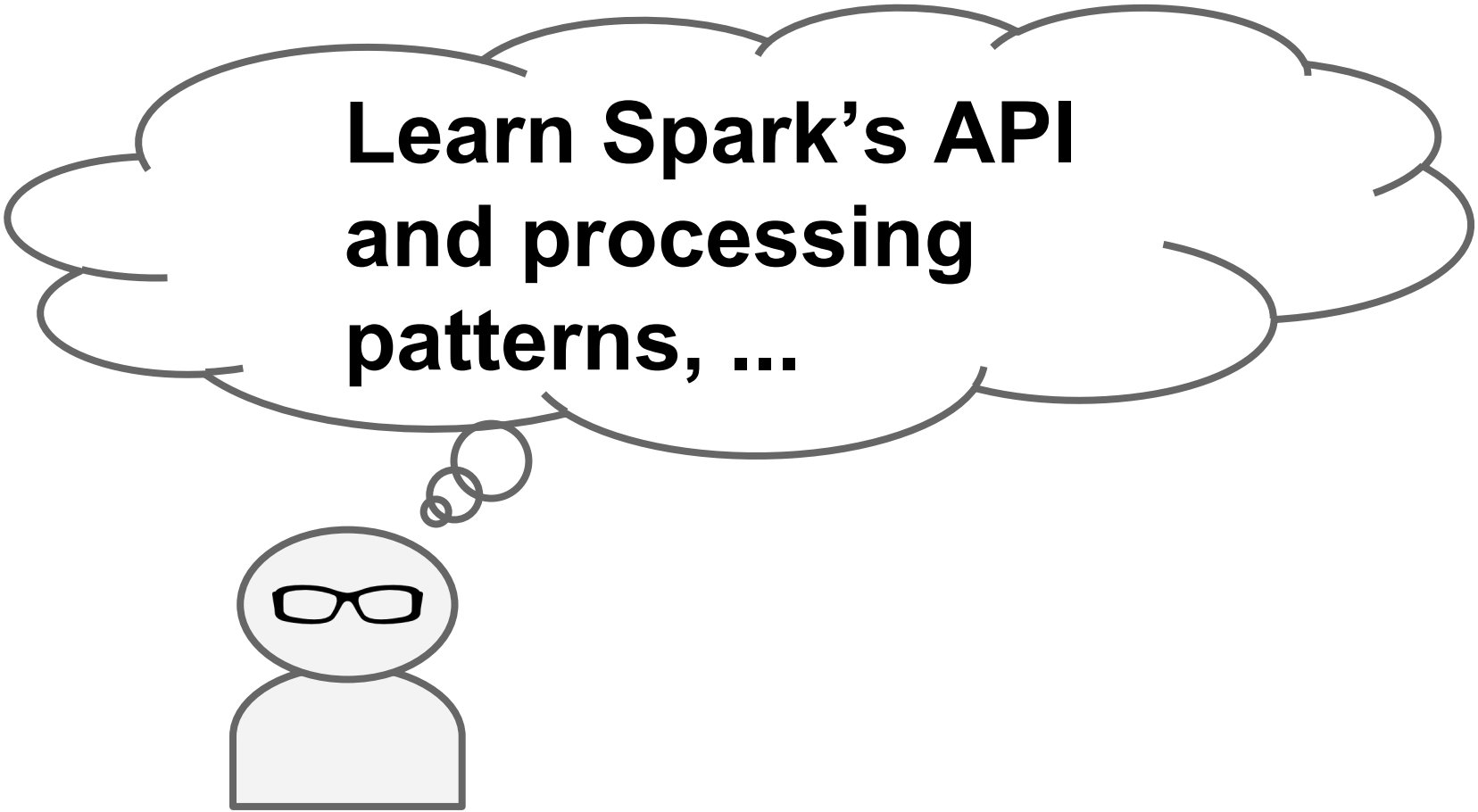
Tuned everything

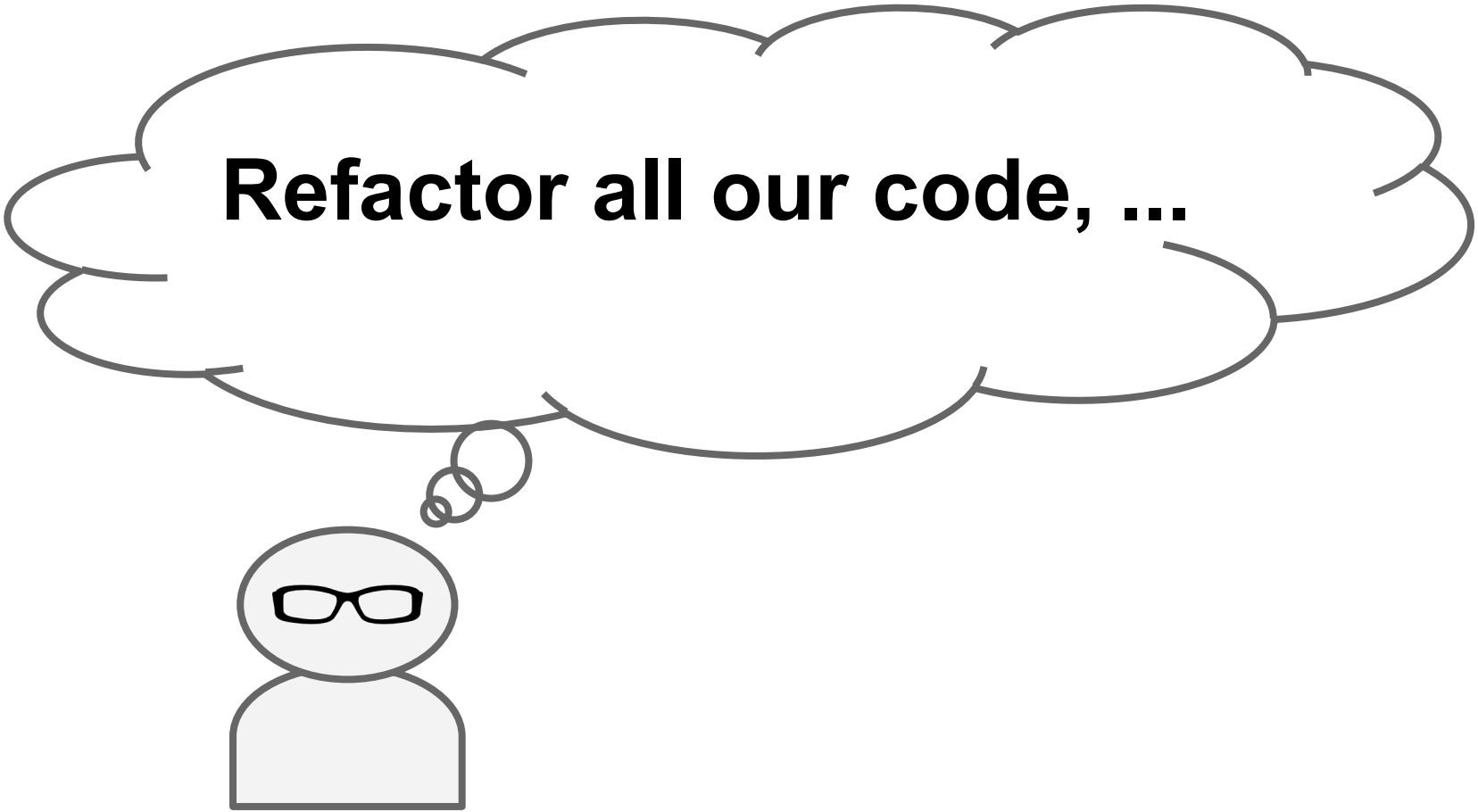
Current Strategy

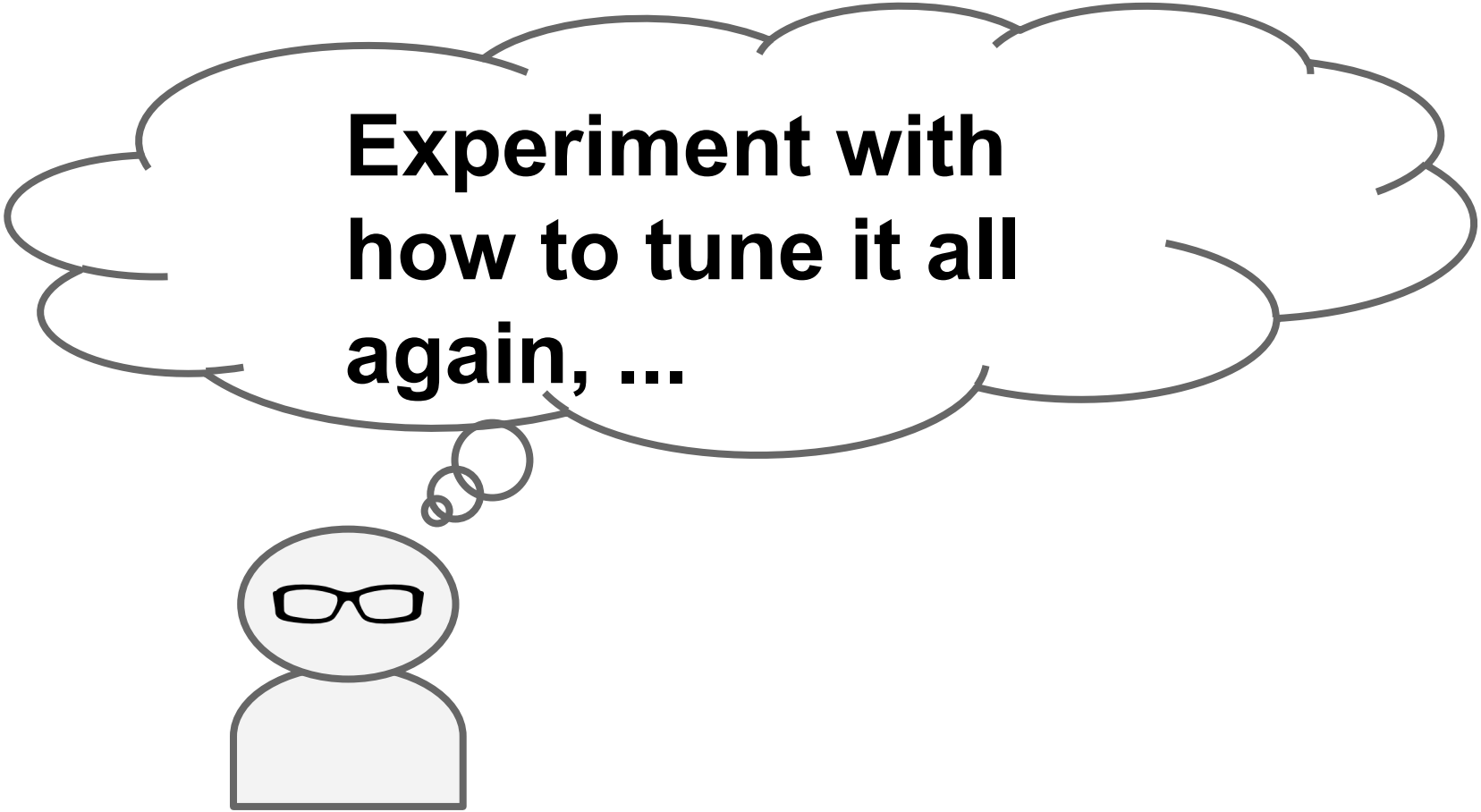
1. Build MR Jobs as needed
2. ????
3. Profit


We should switch to
Spark


Umm what would it take to switch?


Learn Spark's API
and processing
patterns, ...


Refactor all our code, ...


Experiment with how to tune it all again, ...


We don’t use plain MR it won’t be that bad...

- Crunch (http://crunch.apache.org/user-guide.html#sparkpipeline)
- Cascading/Scalding (https://github.com/tresata/spark-scalding)
- Summingbird (will https://github.com/twitter/summingbird/issues/387)


Spark

How Spark is Known..

In Memory

How Spark is Known..

In Memory

100x Faster than MapReduce

How Spark is Known..

SQL, streaming, and complex analytics

A fast and general engine for large-scale data processing.

Spark has an advanced *Directed Acyclic Graph* execution engine that supports cyclic data flow and in-memory computing.

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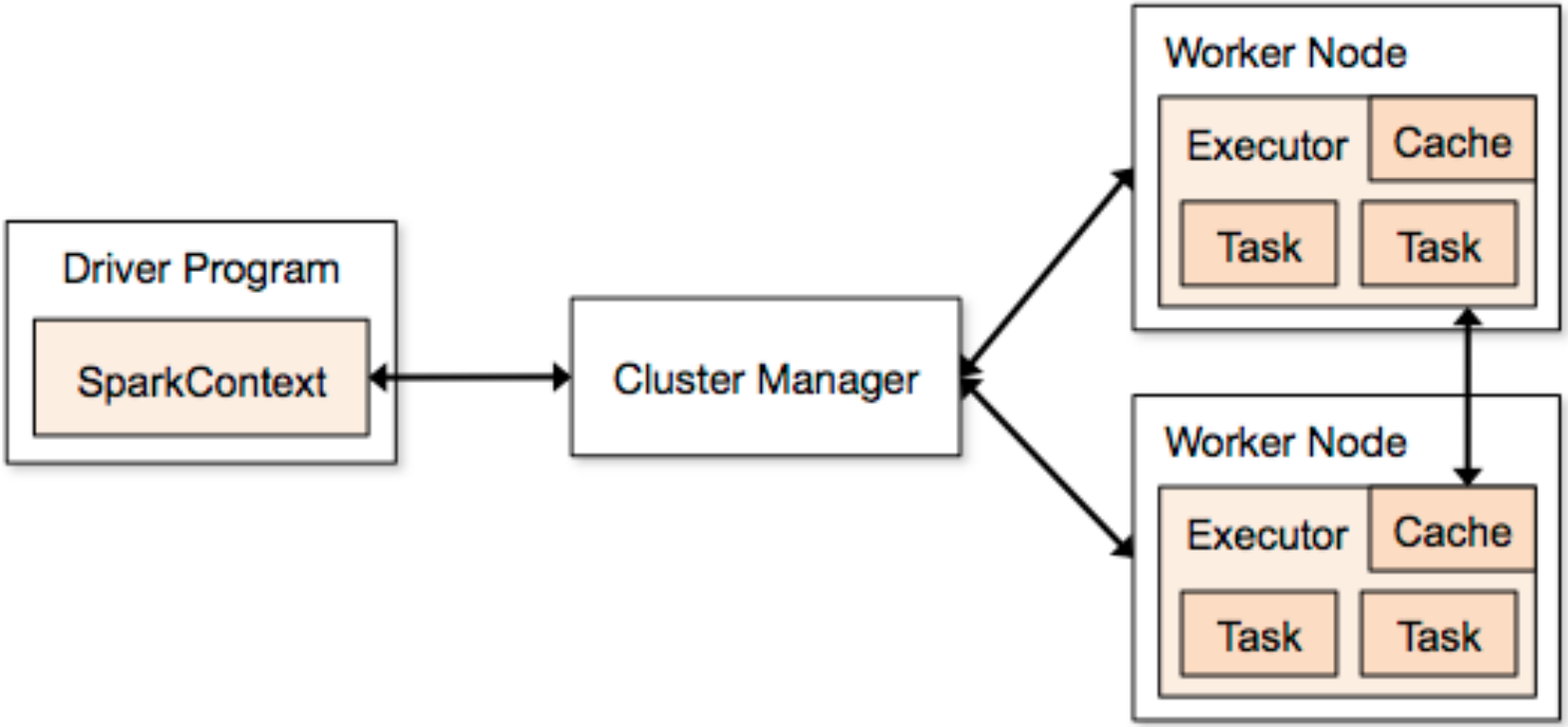

Driver Program
SparkContext
Cluster Manager
Worker Node
Executor
Cache
Task
Task
Worker Node
Executor
Cache
Task
Task

RDD

RDD

Resilient Distributed Dataset

Locality Aware Scheduling

Locality Aware Scheduling

Scalability

Locality Aware Scheduling

Scalability

Fault Tolerant

Locality Aware Scheduling

Scalability **Fault Tolerant**

Applications with working sets

(Parallel ops on intermediate results)

Locality Aware Scheduling

Scalability **Fault Tolerant**

Applications with working sets

(Parallel ops on intermediate results)

Options?

Distributed
Shared Memory
+ Checkpointing

Log Updates

Options?

Log Updates

Log
(coarse-grained)
Updates

Immutable/Read Only

Partitioned

Bad for async updates to shared state

RDDs lifecycle in memory tied to Spark Application

Transformations

Actions

Transformations

map, filter, flatmap, union,
groupByKey, sample

Actions

reduce, collect, count, take

Transformations

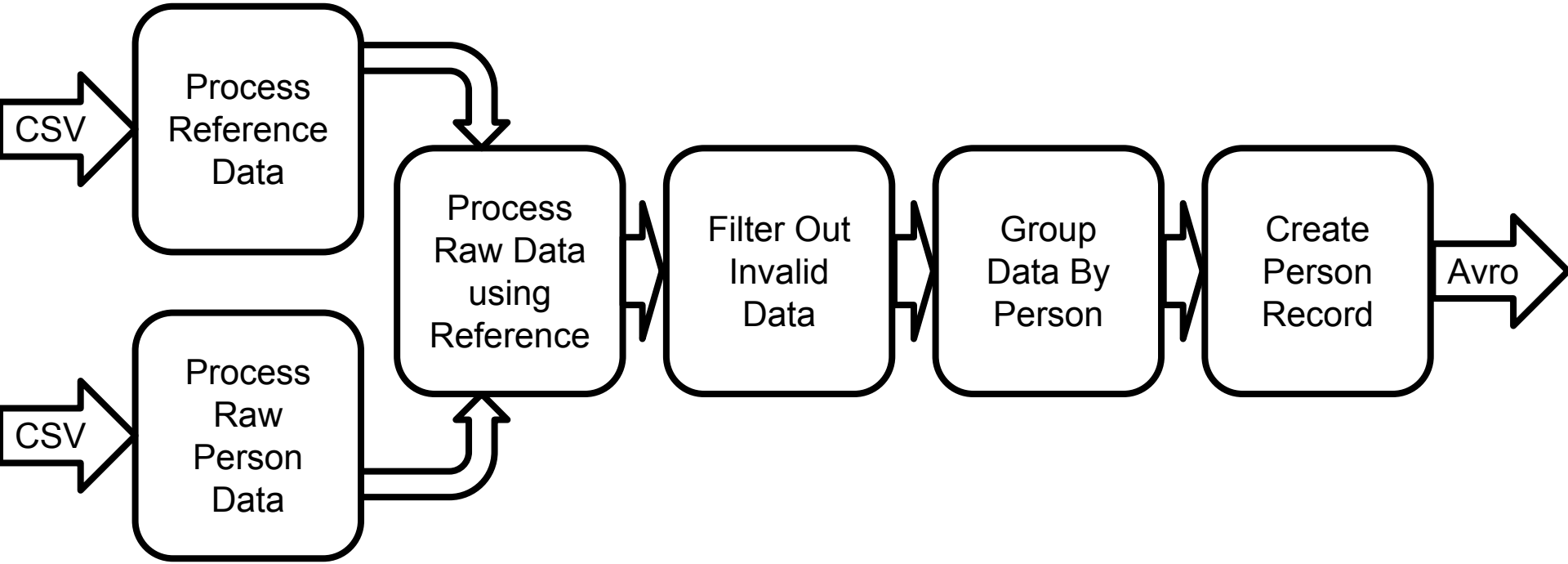
lazily executed

Actions

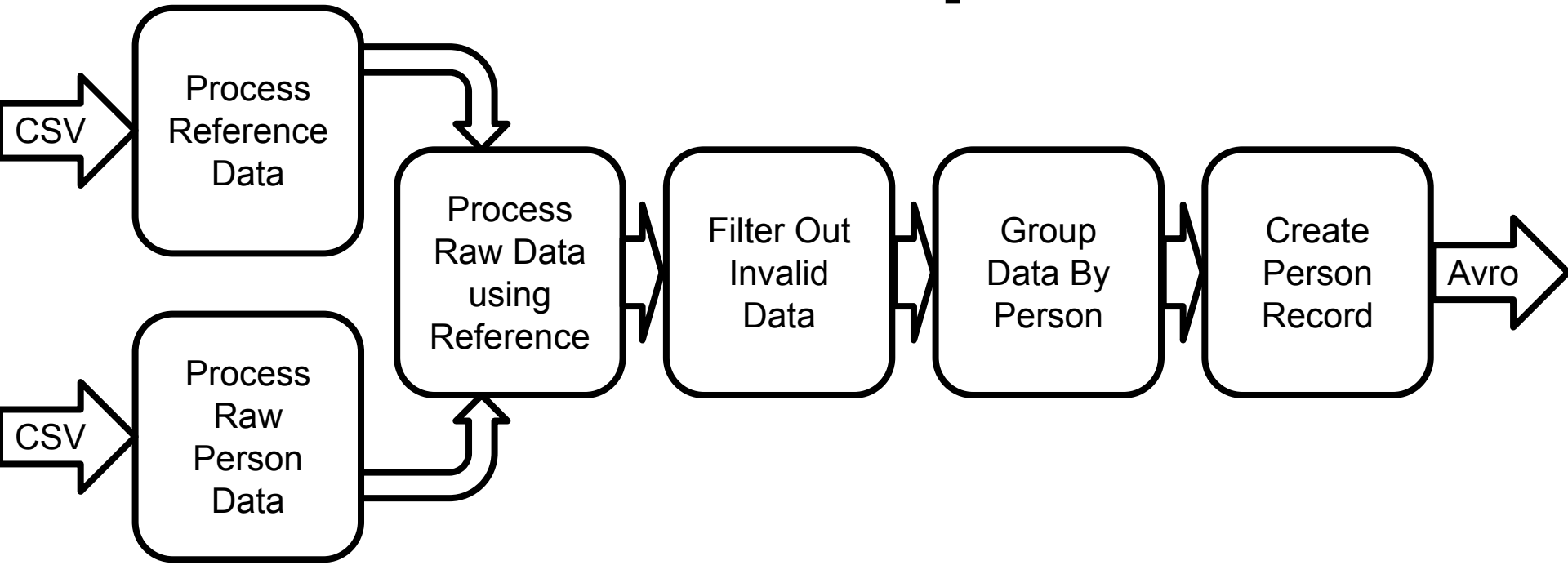
return values to driver

```
val sc = new SparkContext(new SparkConf())
val charCounts = sc.textFile(args(0))
  .flatMap(_.split(" "))
  .flatMap(_.toCharArray).map((_, 1))
charCounts.collect()
// (‘a’, 1)(‘a’, 1)(‘b’, 1)(‘c’, 1)(‘e’, 1)
```

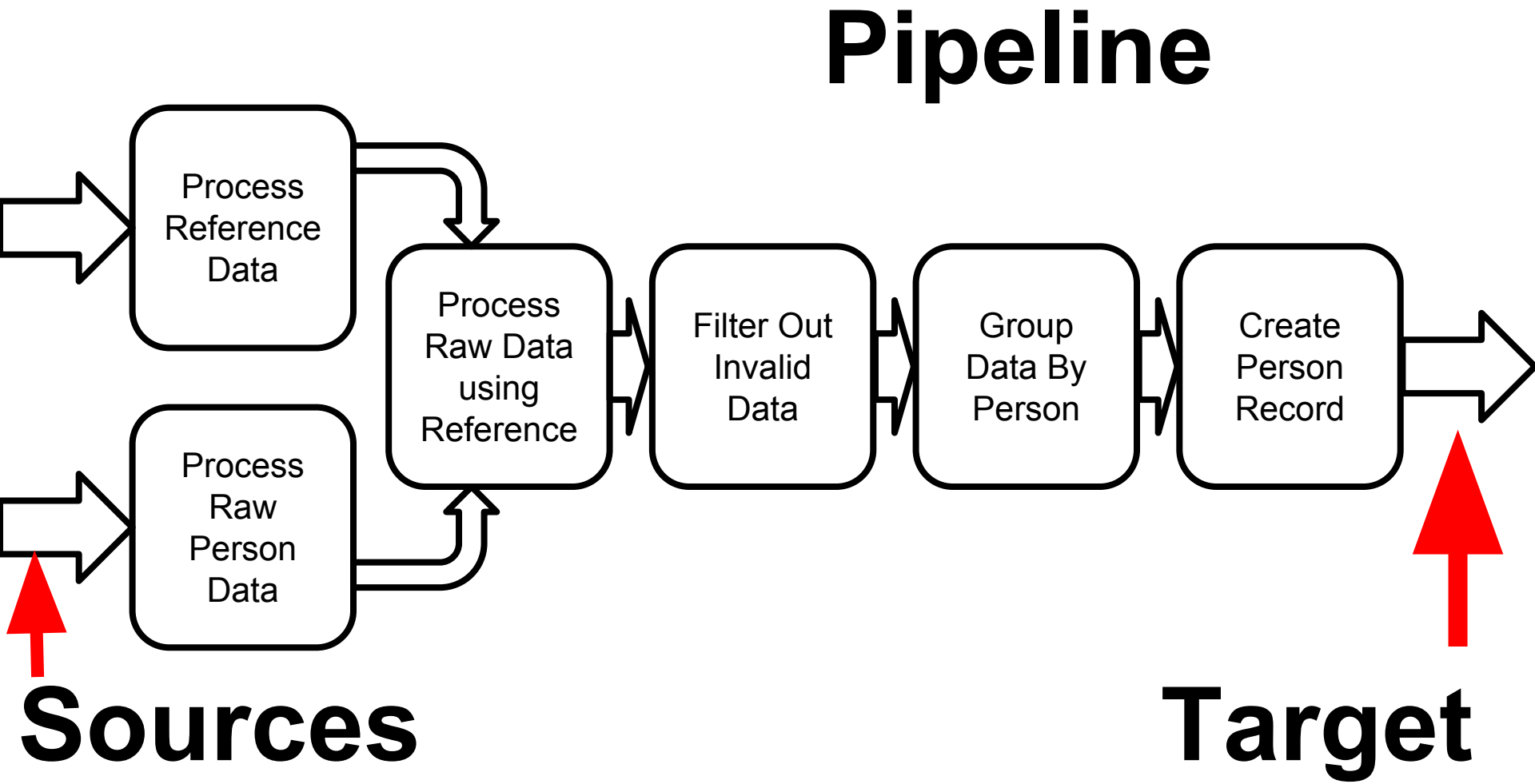
Apache Crunch Review


CSV
Process Reference Data
CSV
Process Raw Person Data
Process Raw Data using Reference
Filter Out Invalid Data
Group Data By Person
Create Person Record
Avro

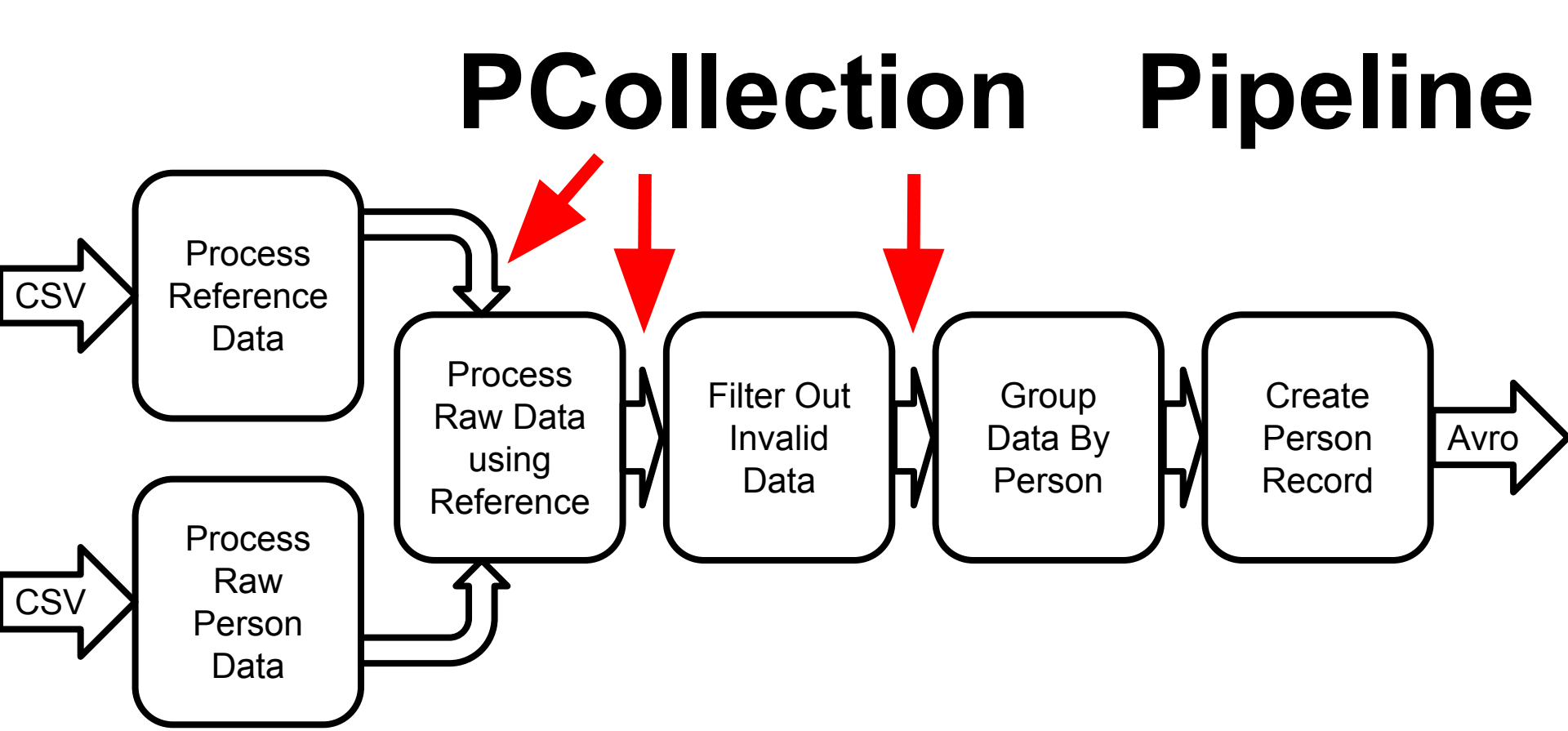
Pipeline


CSV
Process Reference Data
CSV
Process Raw Person Data
Process Raw Data using Reference
Filter Out Invalid Data
Group Data By Person
Create Person Record
Avro

```
Pipeline p = ...
```

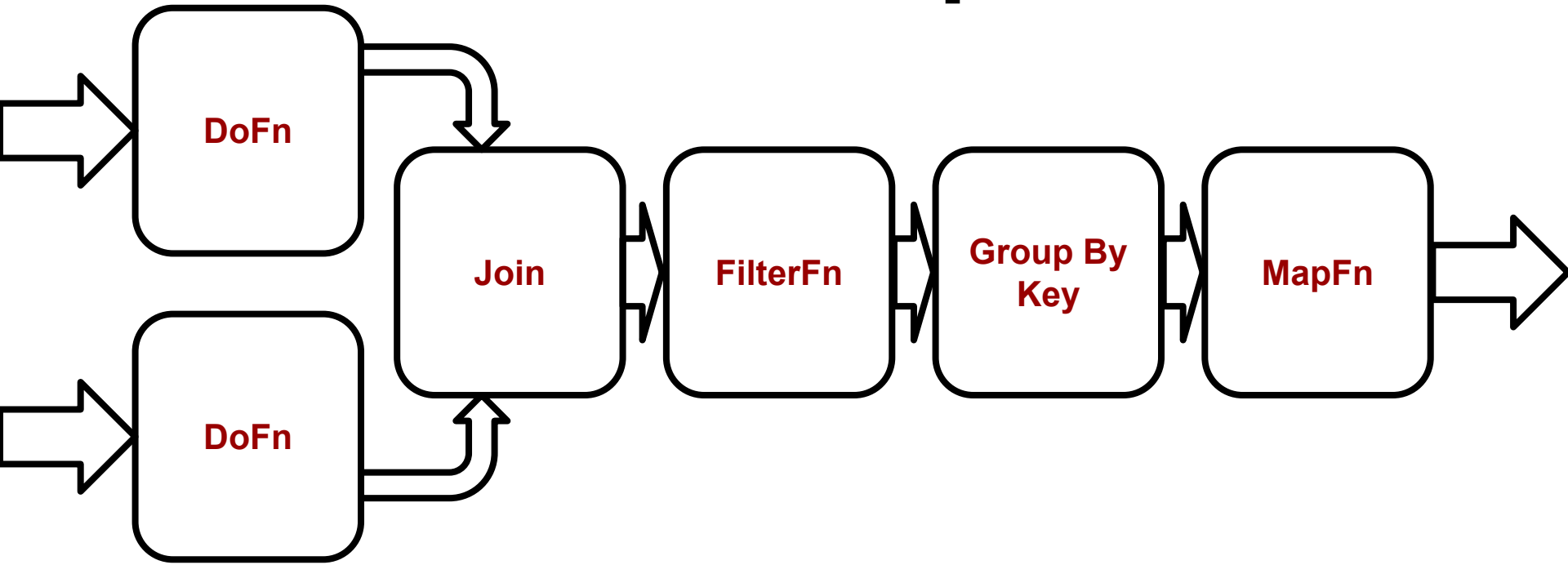

Pipeline
Process Reference Data
Process Raw Person Data
Process Raw Data using Reference
Filter Out Invalid Data
Group Data By Person
Create Person Record
Sources
Target

```
PCollection<String> values =
   p.read(source);
...
values.write(target);
```

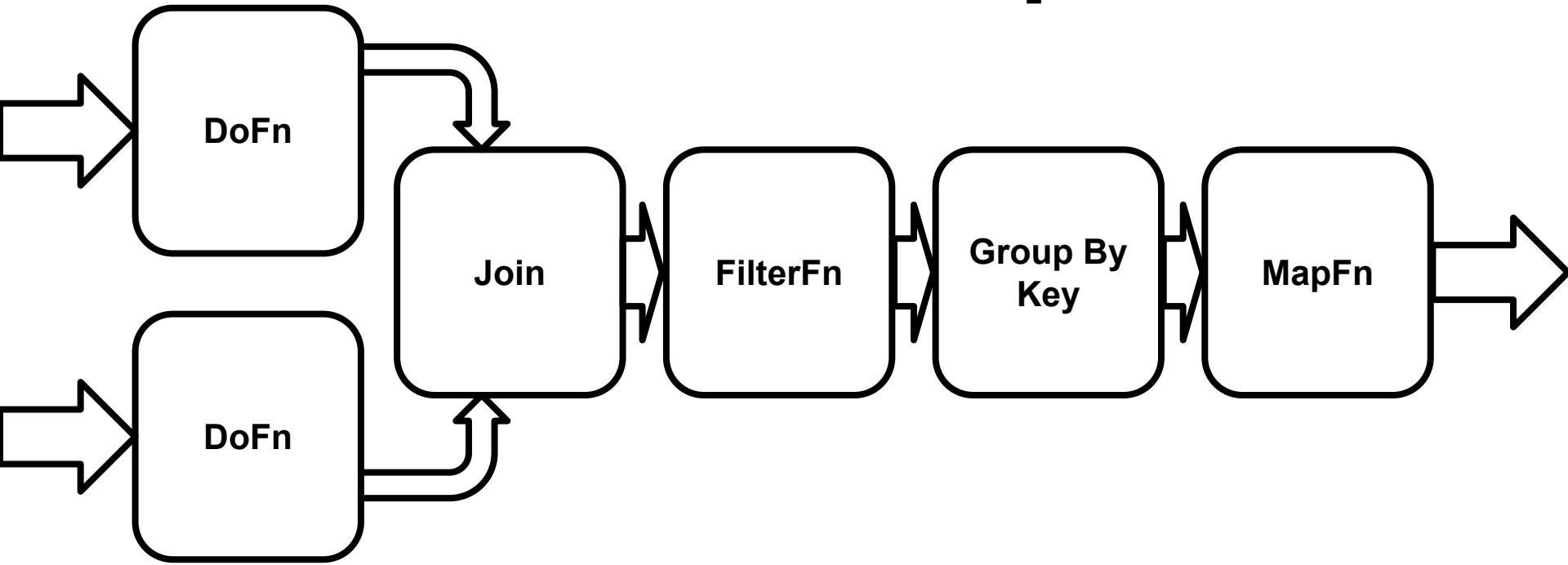

PCollection
Pipeline
CSV
Process Reference Data
CSV
Process Raw Person Data
Process Raw Data using Reference
Filter Out Invalid Data
Group Data By Person
Create Person Record
Avro

```
PCollection<String> values = …
PTable<String, Integer> counts =
  values.parallelDo(fn,ptype);
```

Pipeline

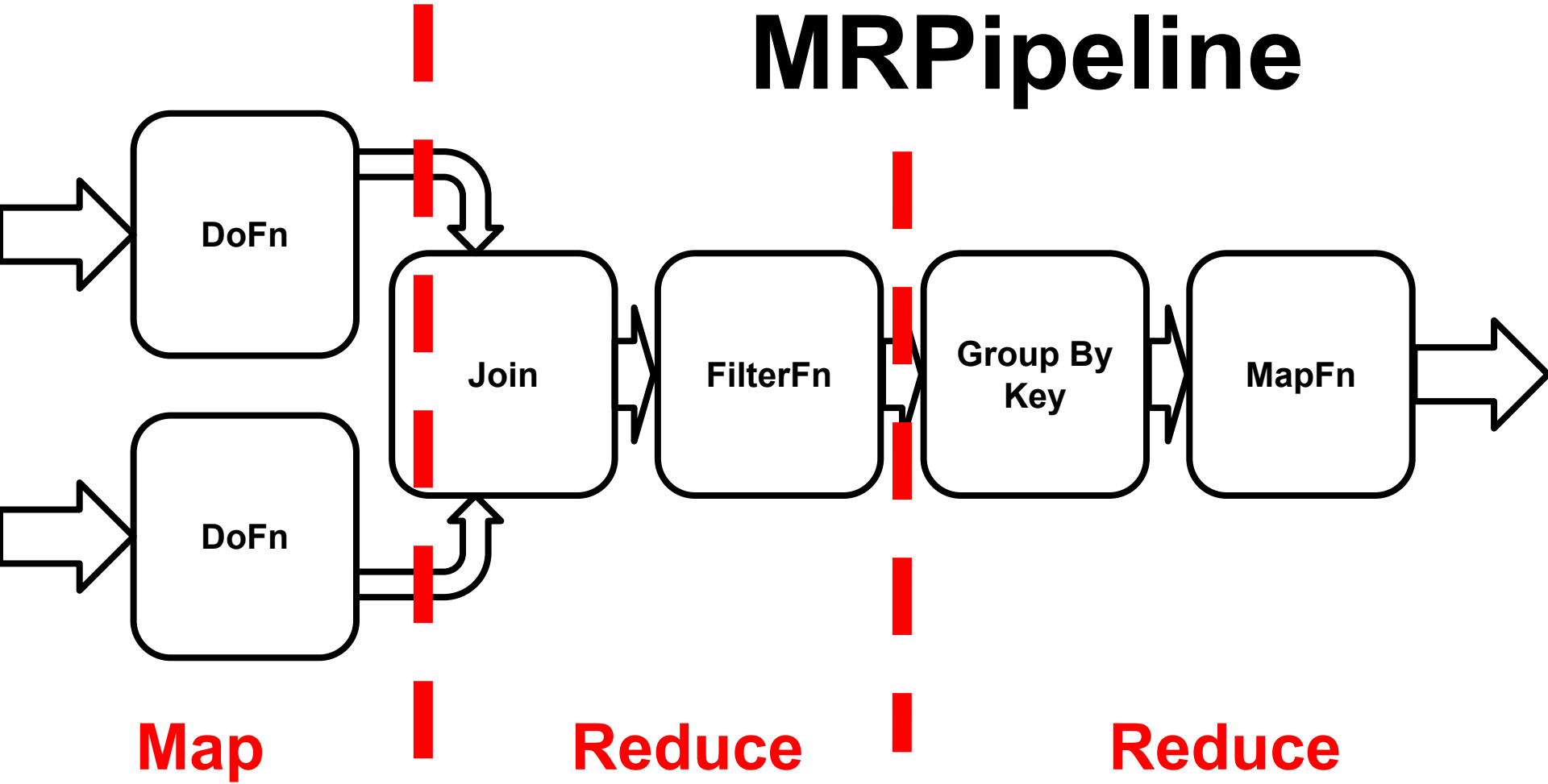


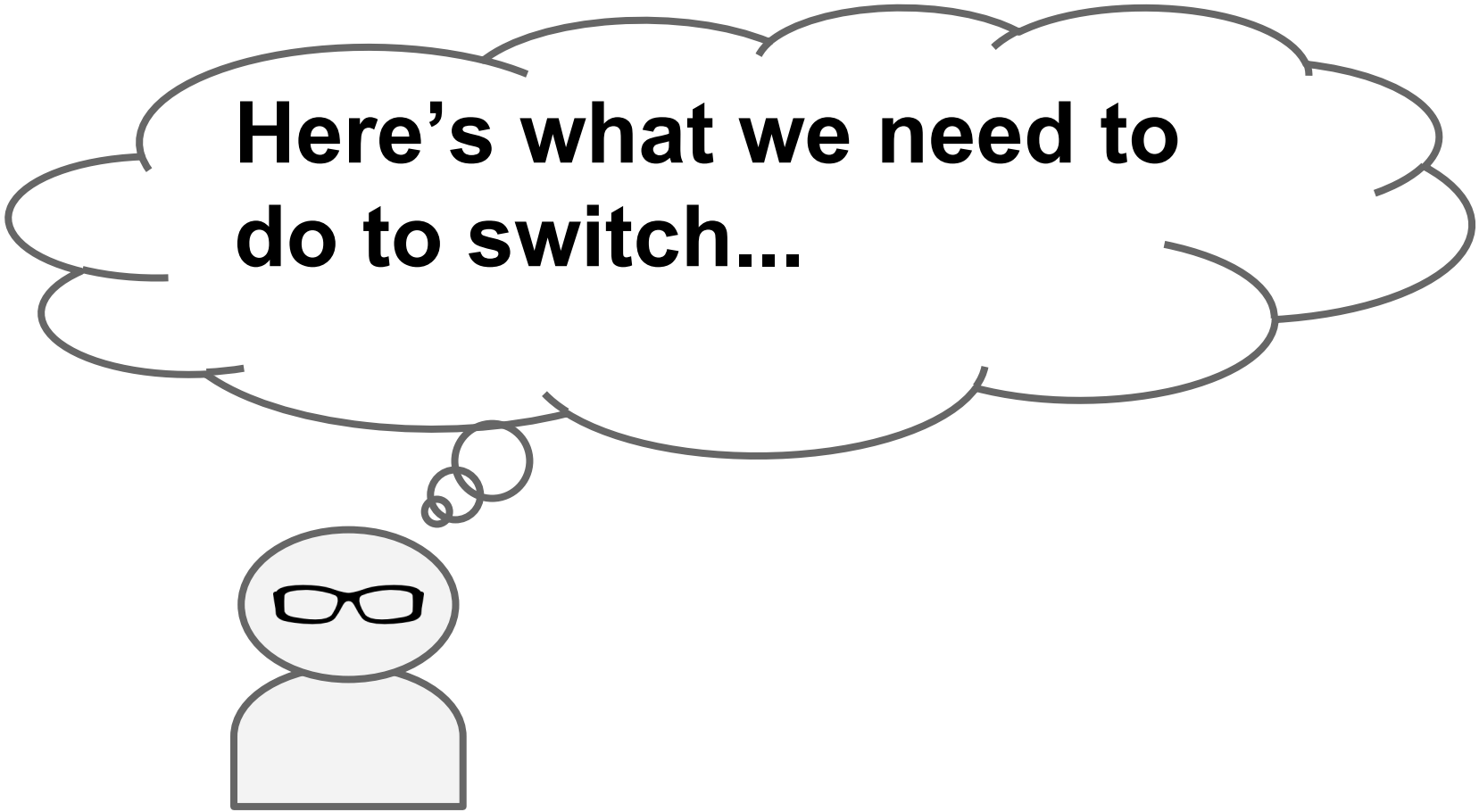
MRPipeline



```
Pipeline p =
   new MRPipeline(
    Driver.class, hadoopConfig);
```

```
PCollection<String> values =
   p.read(...);
<do processing>
p.write(...);
p.done();
```


MRPipeline
DoFn
DoFn
Join
FilterFn
Group By Key
MapFn
Map
Reduce
Reduce


Here’s what we need to do to switch...

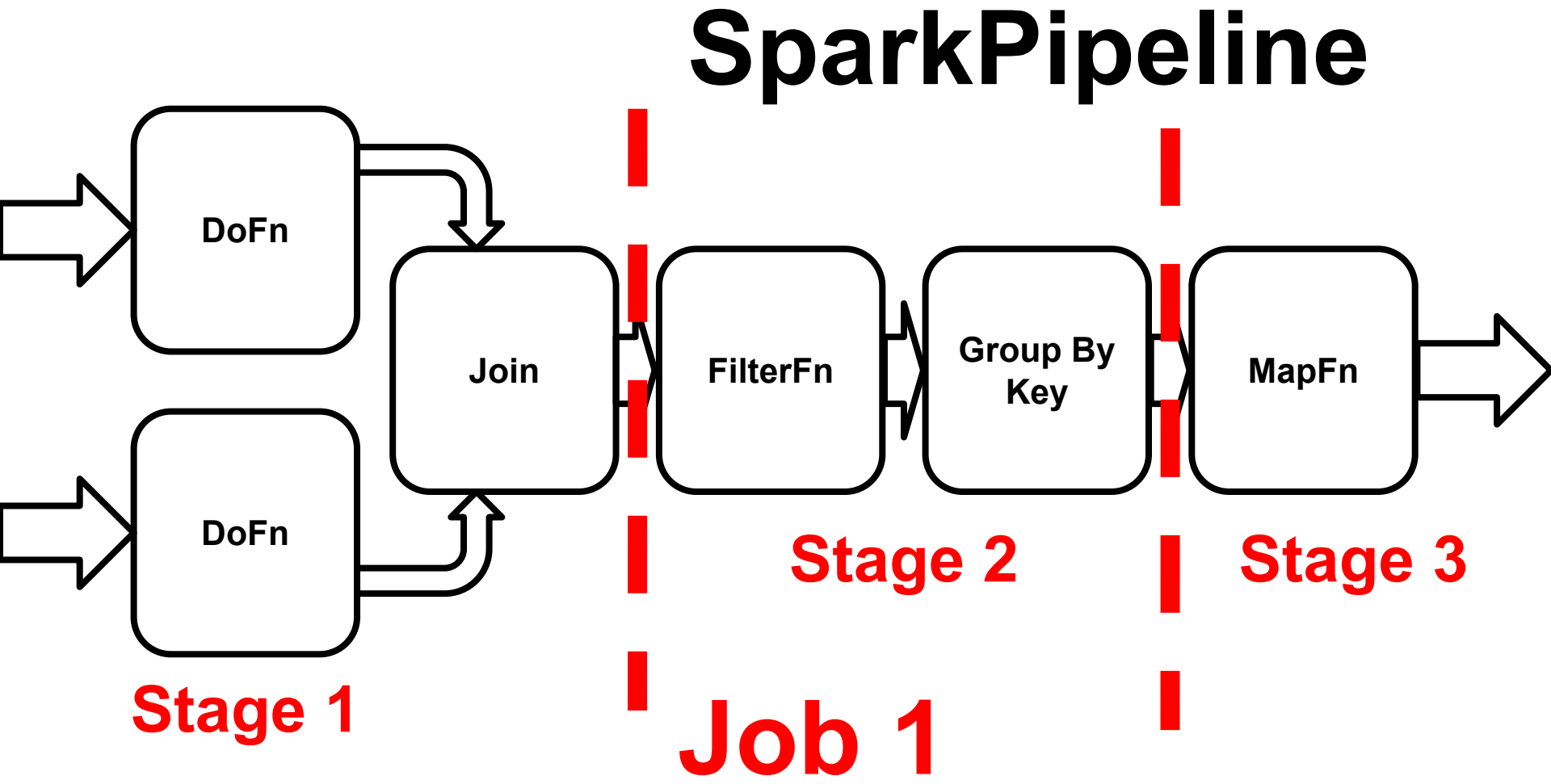
```
<dependency>
    <groupId>org.apache.spark</groupId>
    <artifactId>spark-core_2.10</artifactId>
    <version>${sparkVersion}</version>
    <scope>provided</scope>
</dependency>
<dependency>
    <groupId>org.apache.crunch</groupId>
    <artifactId>crunch-spark</artifactId>
    <version>${crunchVersion}</version>
    <scope>compile</scope>
</dependency>
```

```
Pipeline p =
   new MRPipeline(
    Driver.class, hadoopConfig);
```

```
Pipeline p =
   new SparkPipeline(
    “spark://localhost:7077”,
    “Spark App Name”);
```

```
hadoop jar myjar.jar
   com.example.Driver ...
```

```
spark-submit
  --class com.example.Driver
  --master spark://localhost:7077
  ...
```


SparkPipeline
DoFn
DoFn
Join
FilterFn
Group By Key
MapFn
Stage 1
Stage 2
Stage 3
Job 1


That’s not too bad...


Well there are
some differences
to account for...

Crunch with MRPipeline minimizes I/O

Crunch with SparkPipeline defers planning to Spark

MRPipeline

SparkPipeline

MRPipeline **SparkPipeline**

Supports multiple writes

MRPipeline **SparkPipeline**

Supports multiple writes

Performs multiple writes in same task/stage

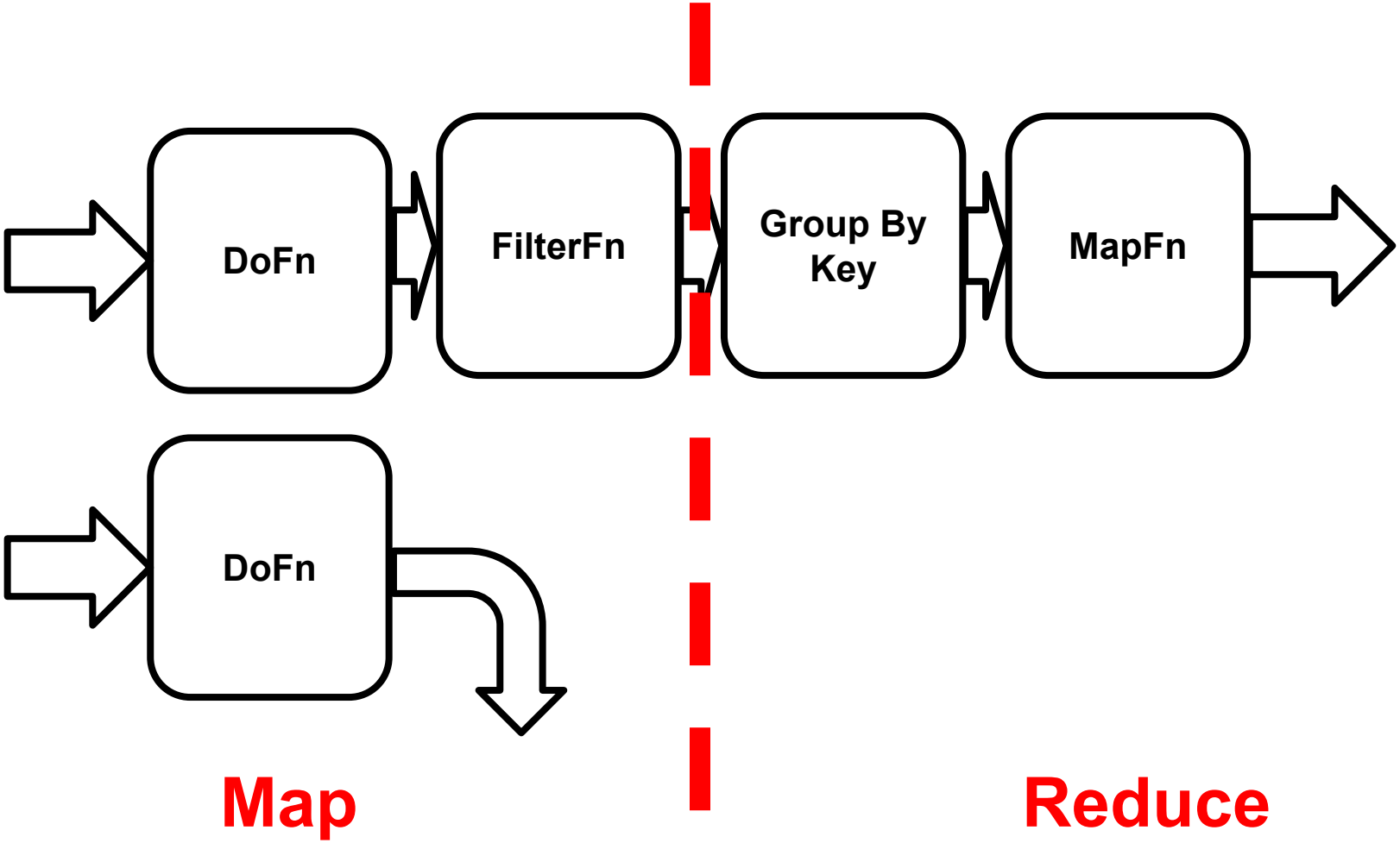
MRPipeline

SparkPipeline

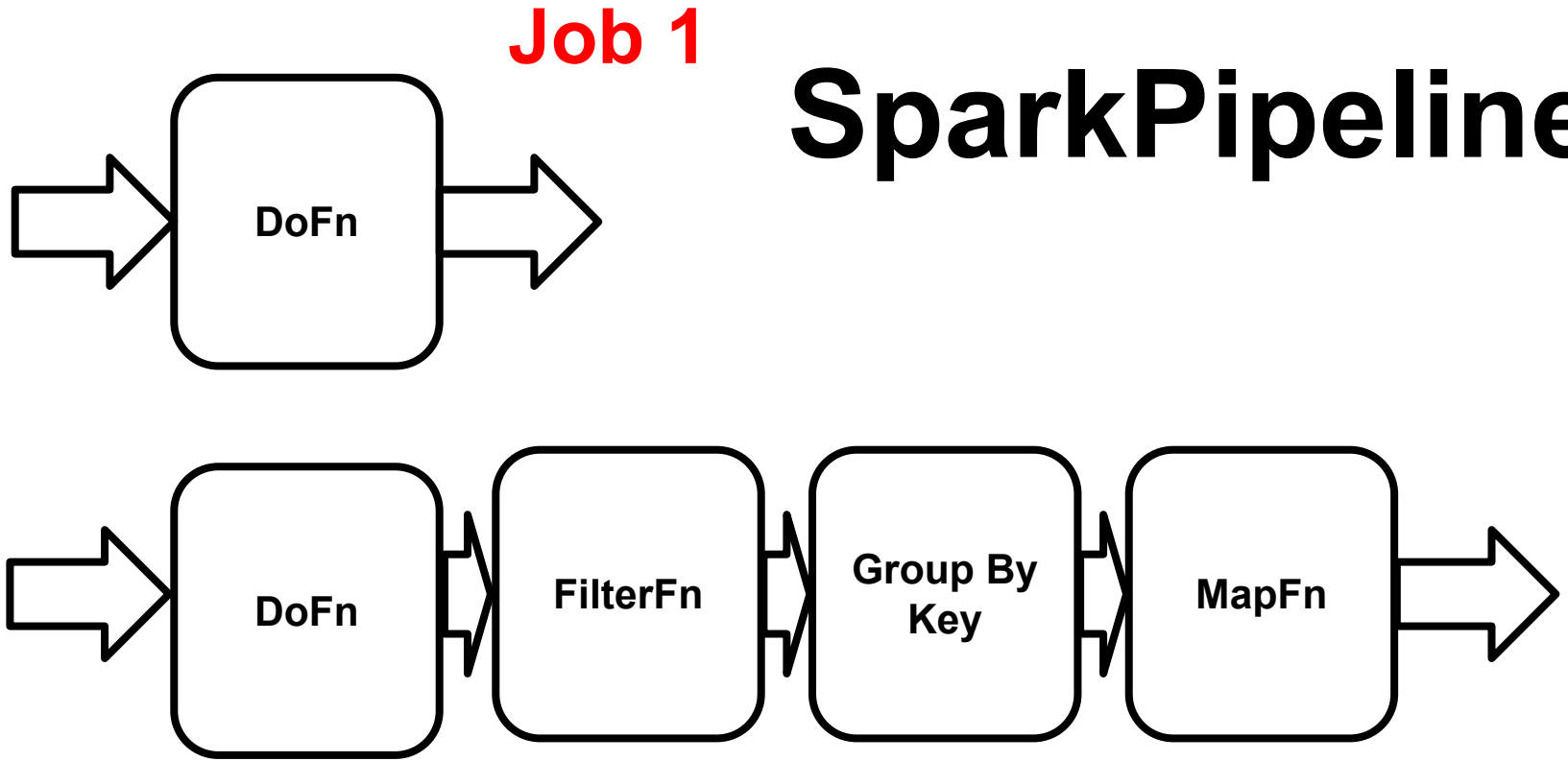
Supports multiple writes

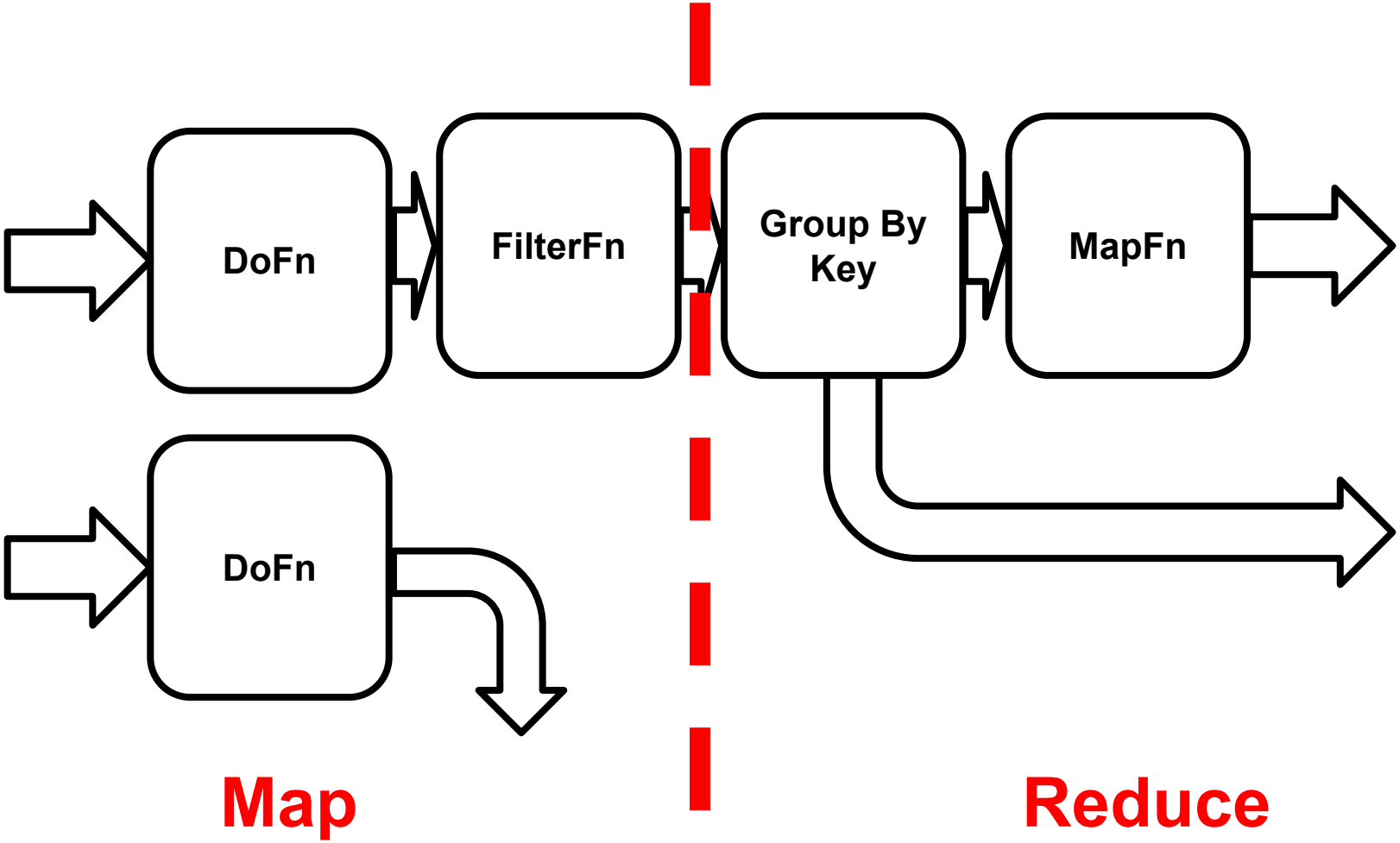
Performs multiple writes in same task/stage

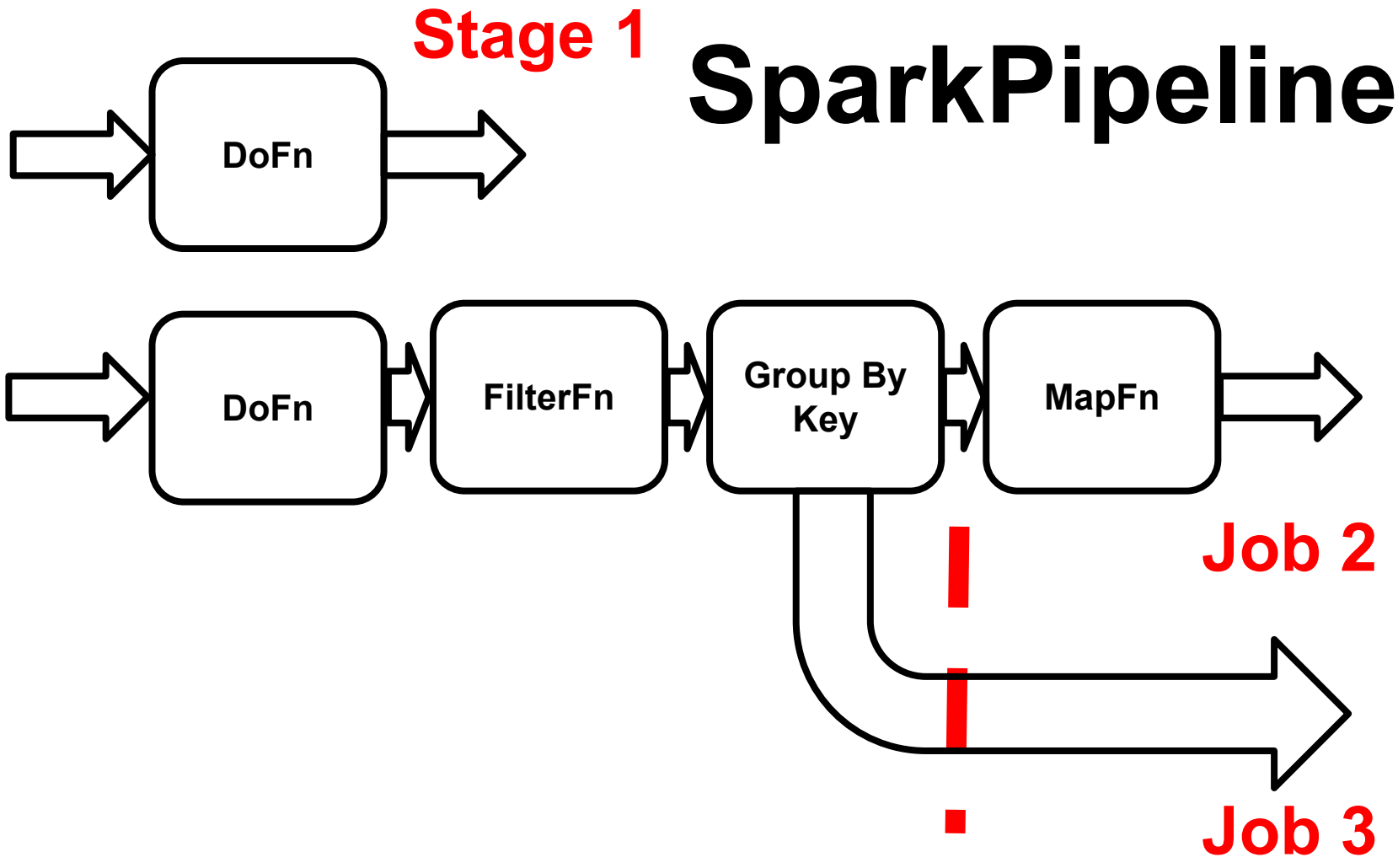
Serial writes in separate task/stages

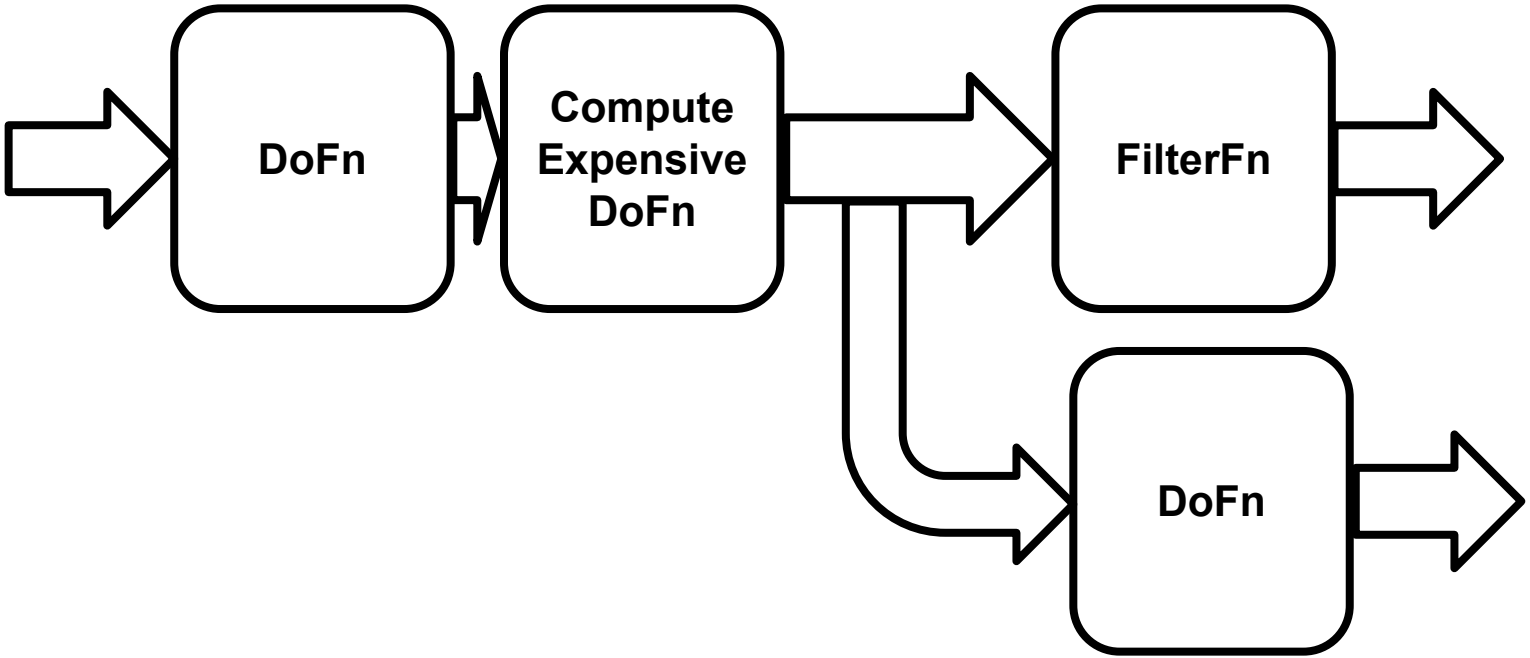

DoFn
FilterFn
Group By Key
MapFn
DoFn
Map
Reduce

SparkPipeline



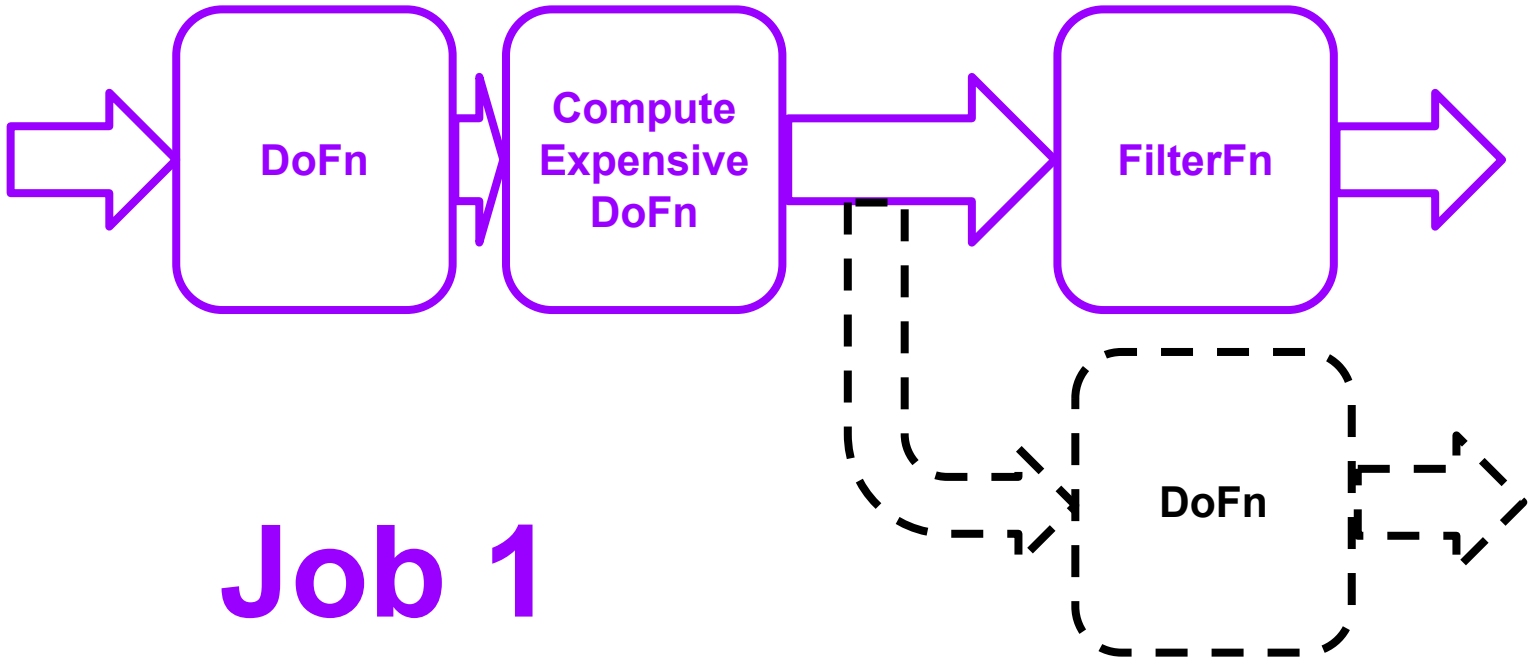

DoFn
FilterFn
Group By Key
MapFn
DoFn
Map
Reduce

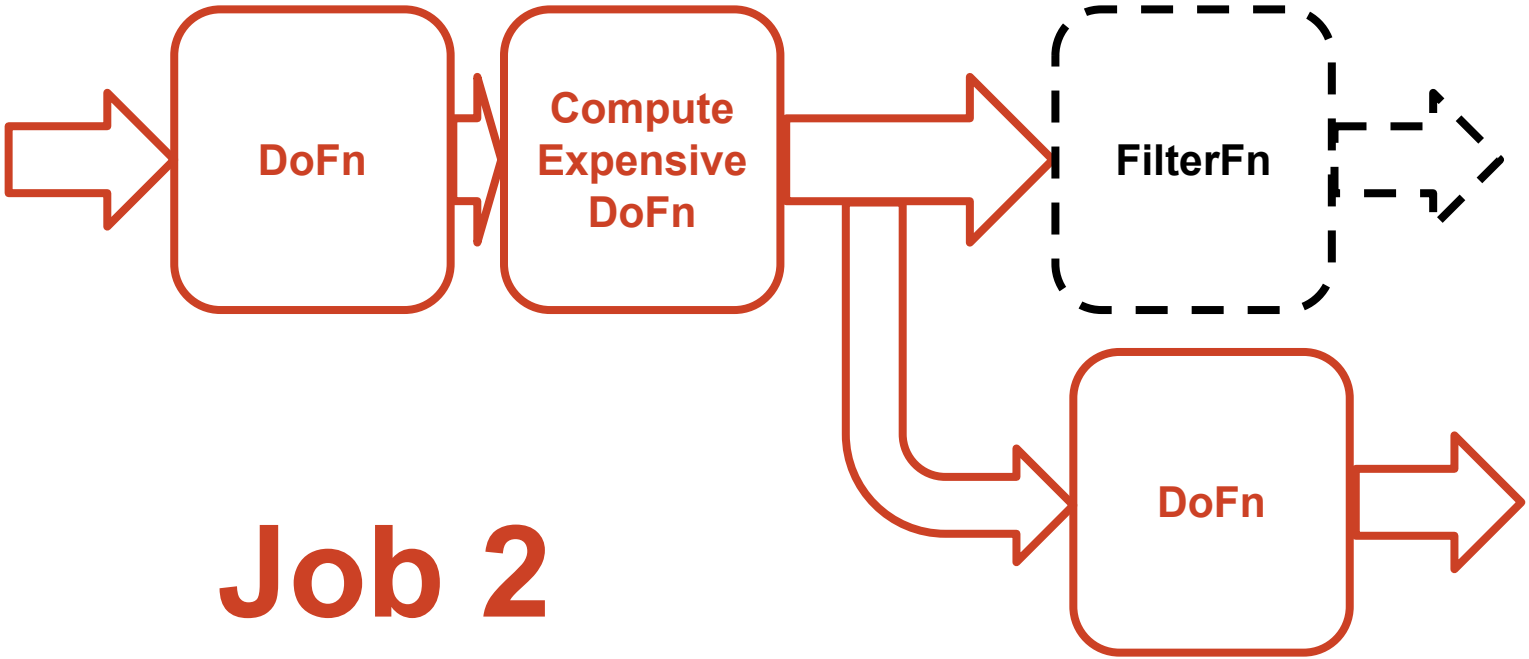

Stage 1
SparkPipeline
DoFn
DoFn
FilterFn
Group By Key
MapFn
Job 2
Job 3

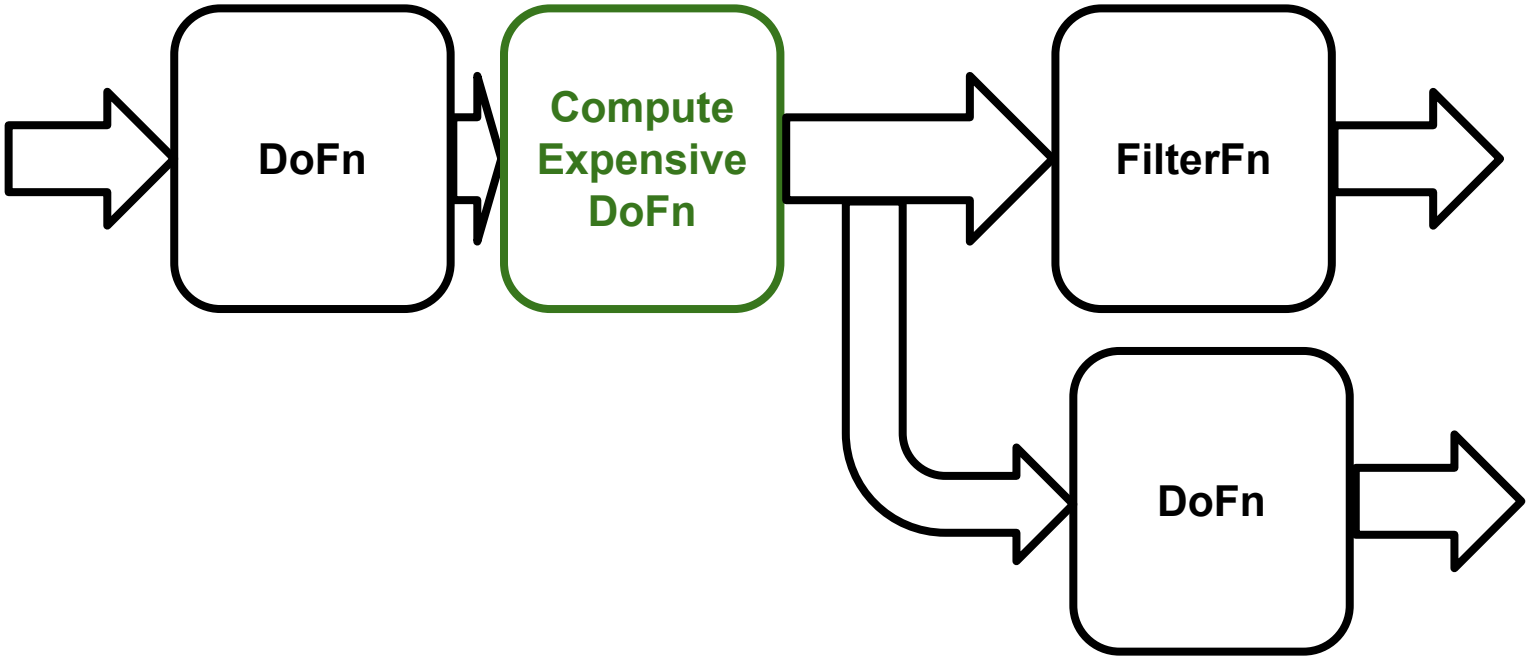

DoFn
Compute Expensive DoFn
FilterFn
DoFn

Spark is lazy

Action needed for something to happen


DoFn
Compute Expensive DoFn
FilterFn
DoFn
Job 1


DoFn
Compute Expensive DoFn
FilterFn
DoFn
Job 2


DoFn
Compute Expensive DoFn
FilterFn
DoFn

Limit expensive computations

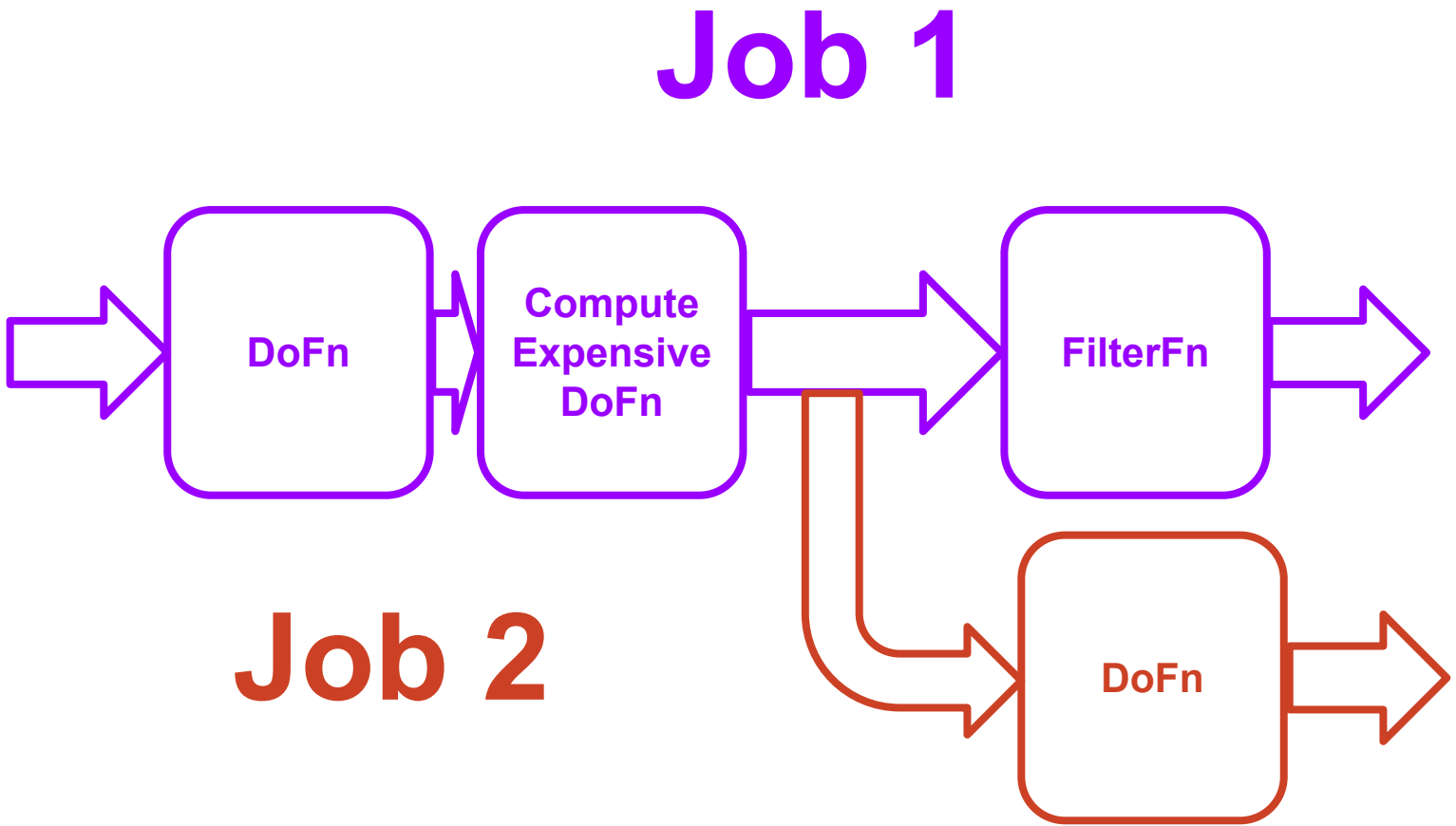
Keep RDDs around for reuse

Spark supports persisting RDDs in memory

```
rdd.persist()
```

```
rdd.persist(
   StorageLevel.MEMORY_ONLY)
```

**DISK_ONLY, DISK_ONLY_2,
MEMORY_AND_DISK, MEMORY_AND_DISK_2,
MEMORY_AND_DISK_SER,
MEMORY_AND_DISK_SER_2, MEMORY_ONLY,
MEMORY_ONLY_2, MEMORY_ONLY_SER,
MEMORY_ONLY_SER_2, NONE, OFF_HEAP**


Job 1
DoFn
Compute Expensive DoFn
FilterFn
Job 2
DoFn

```
PCollection<String> values =
  //expensive computation
values.cache();
```

```
PCollection<String> values =
  //expensive computation
CacheOptions opts = new
  CacheOptions.Builder()
  .useDisk(true).useMemory(true)
  .build();
values.cache(opts);
```

Spark needs to be able to serialize data

Send data between workers

Persist data in memory or disk

Spark supported serialization

Java Serializable (and Externalizable)

Kyro Serialization

Spark recommends Kryo

Extra config on the SparkConfig

Custom serializer registration

Spark on Crunch

Hides serialization behind PTypes

Handles complex records like Avro

Spark on Crunch

Hides serialization behind PTypes

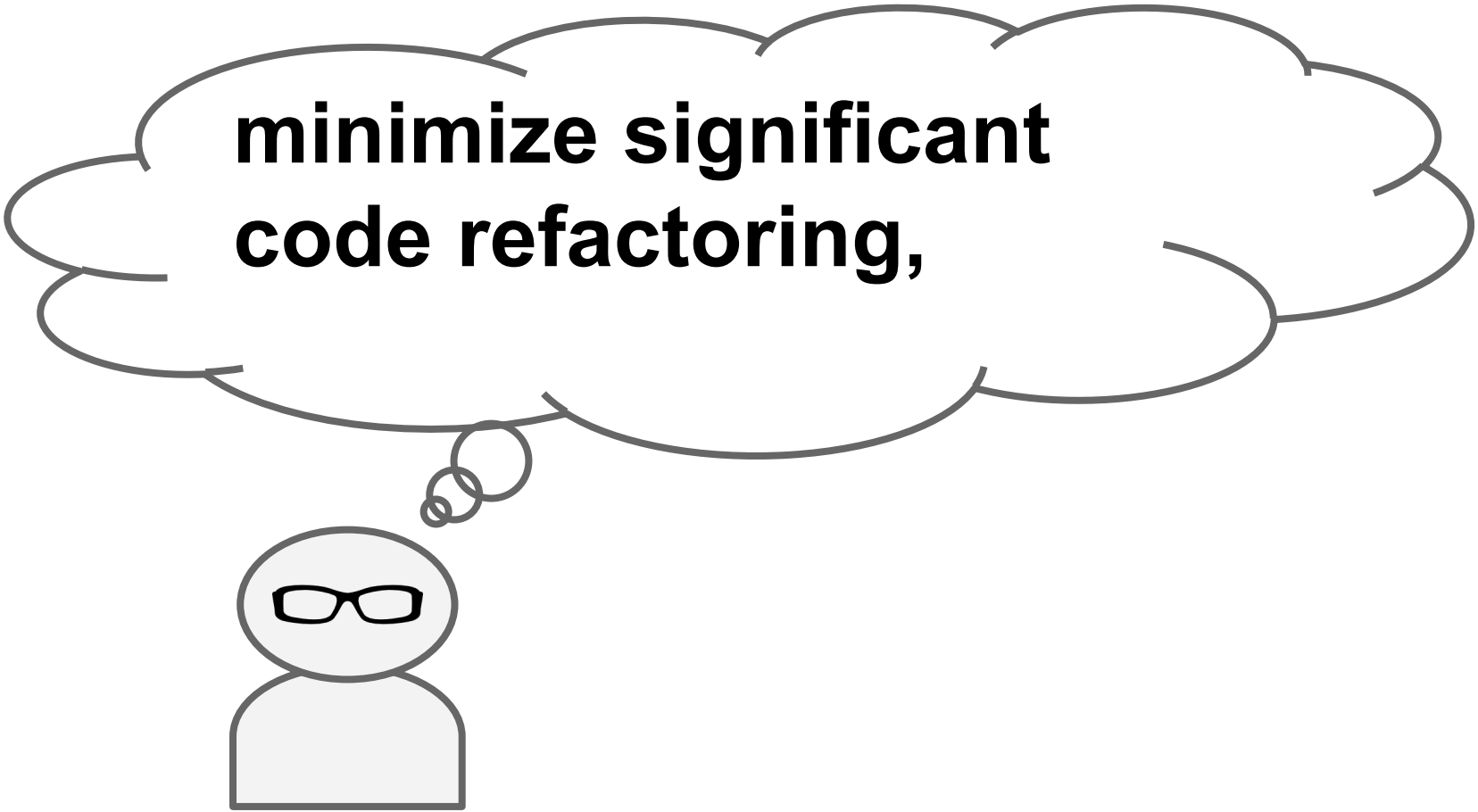
Handles complex records like Avro

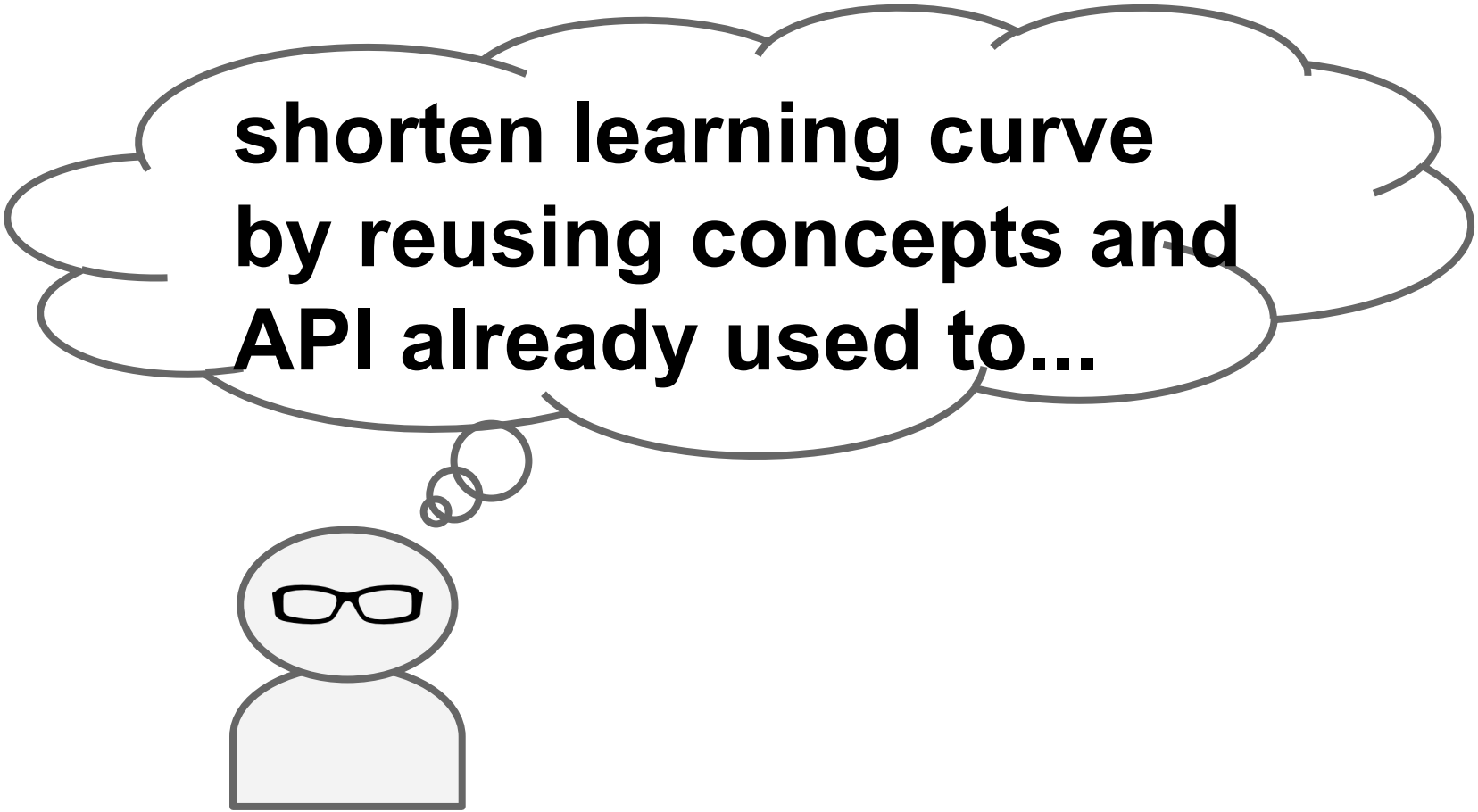
Additional Topics to Explore

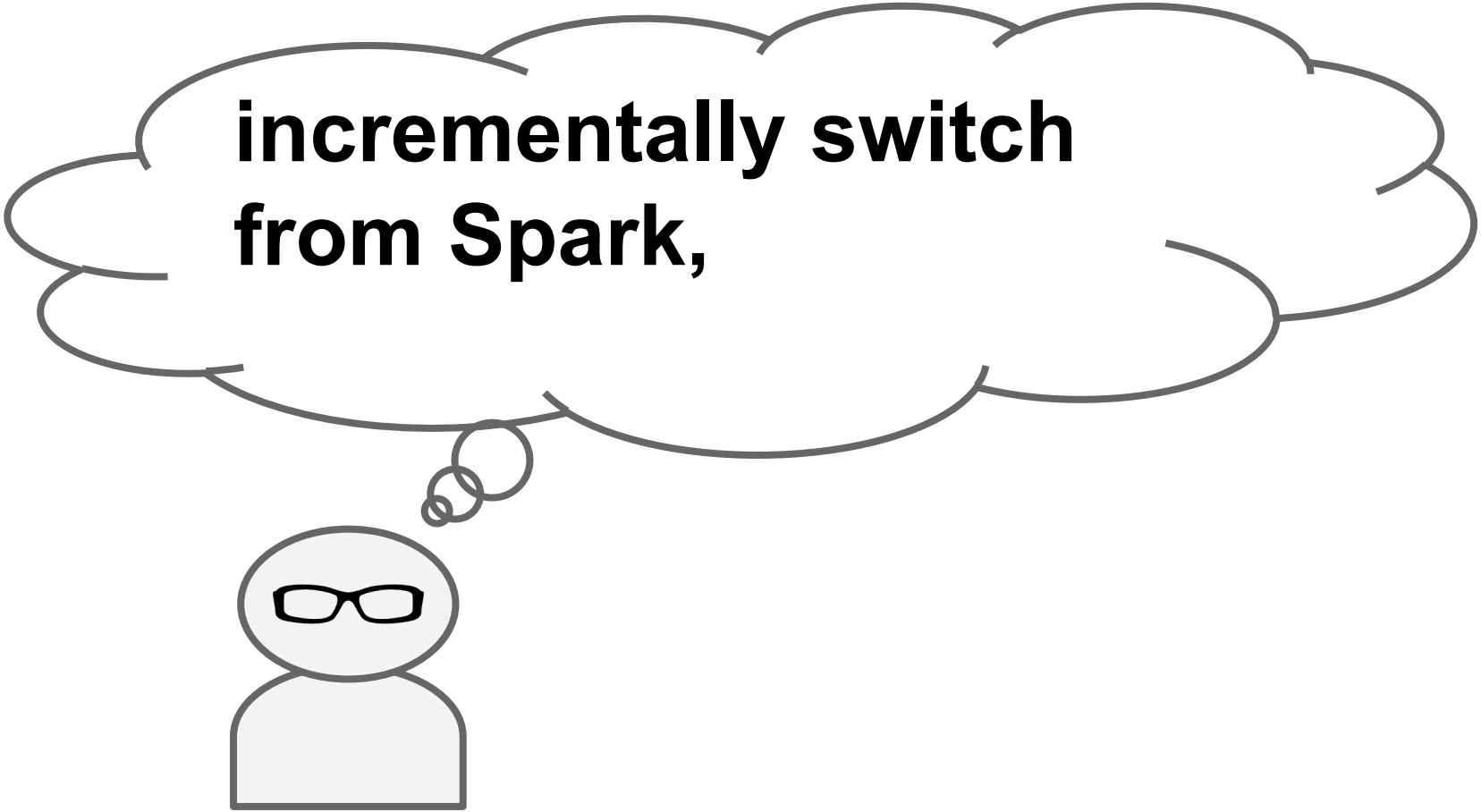
Aggregation sort behaviors

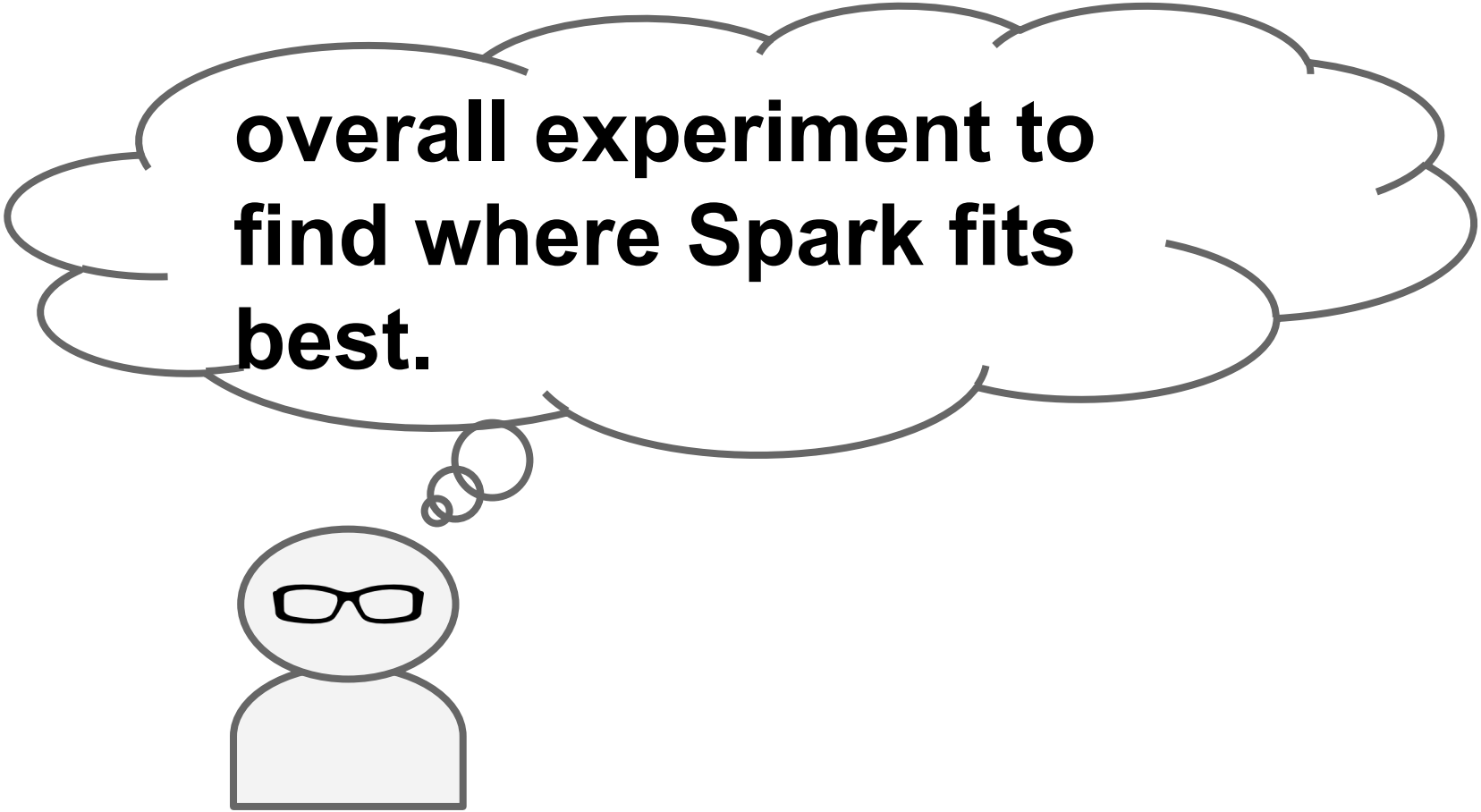
Reusing Crunch Functions in Spark

With Crunch, we'll be able to ...


minimize significant
code refactoring,


shorten learning curve
by reusing concepts and
API already used to...


incrementally switch
from Spark,


overall experiment to find where Spark fits best.

Links:

- http://crunch.apache.org/
- http://spark.apache.org/docs/latest/
- **Examples:** https://github.com/mkwhitacre/simplesparkapp

Special Thanks...

- Josh Wills - helped come up with content
- Sean Owen & Sandy Ryza whose repo I forked to build examples and experiment