

Querying Data with MapReduce

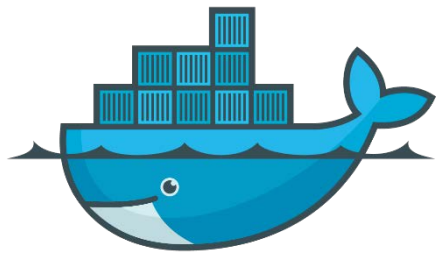
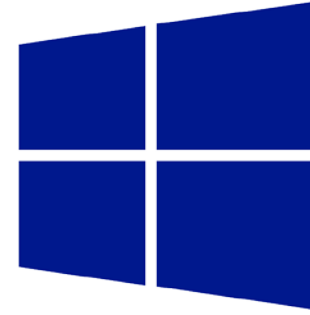


Elton Stoneman

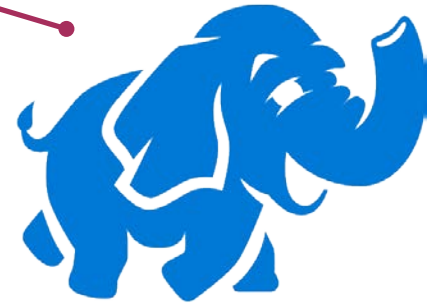
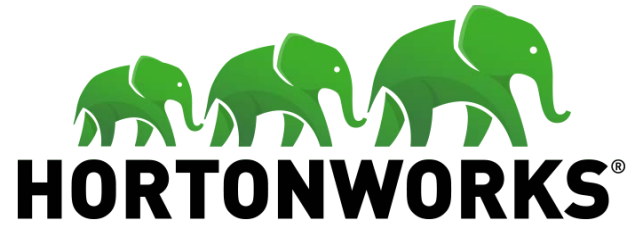
SOFTWARE ARCHITECT

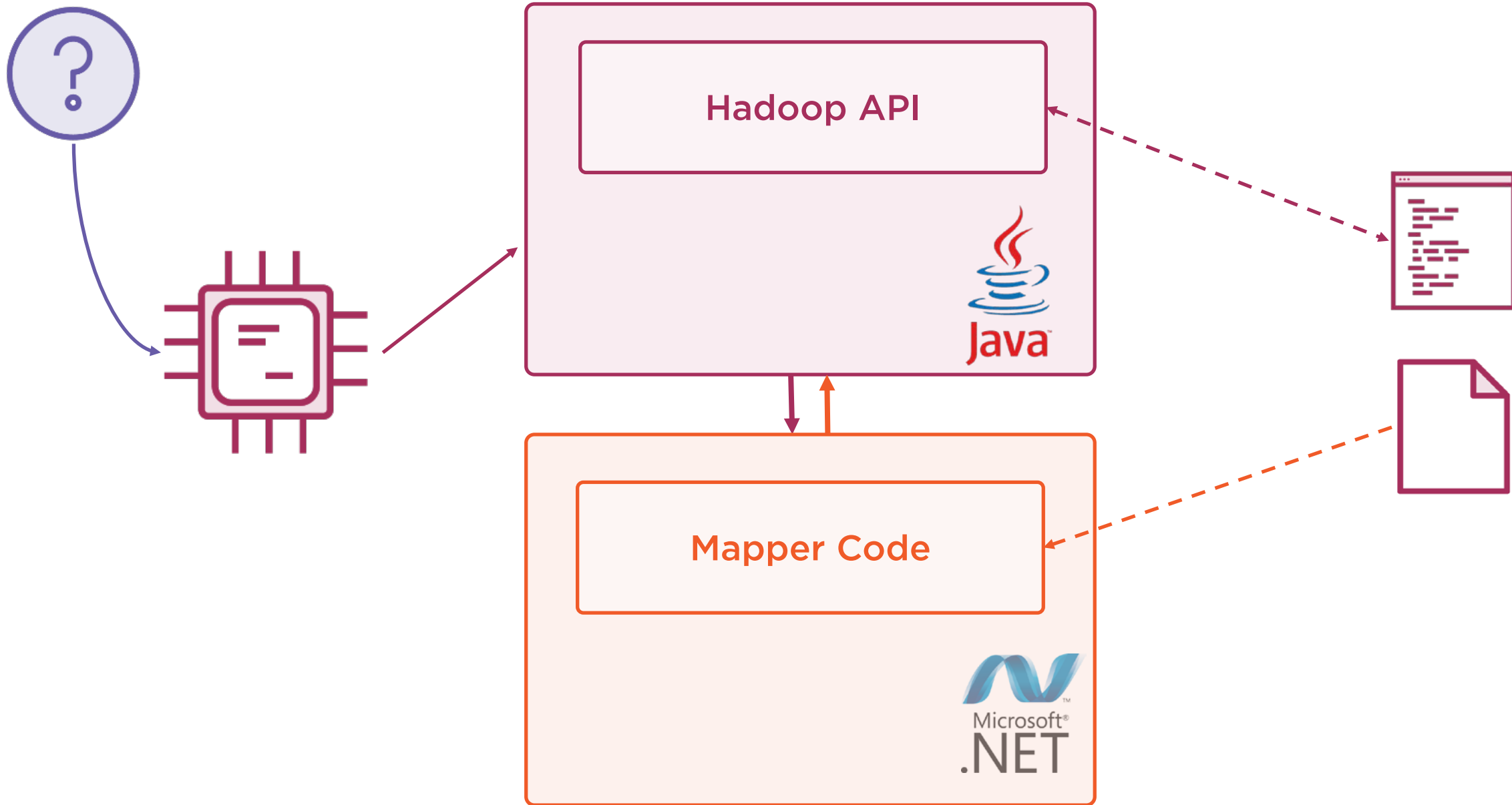
@EltonStoneman blog.sixeyed.com

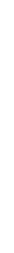




docker









Older Workers...->1



Older Workers...->1



Older Workers...->1



Older Workers...->{1,1,1}

Map phase

Merged by key

Sorted by key

Rural life -> {1,1...}

Student digs -> {1,1...}

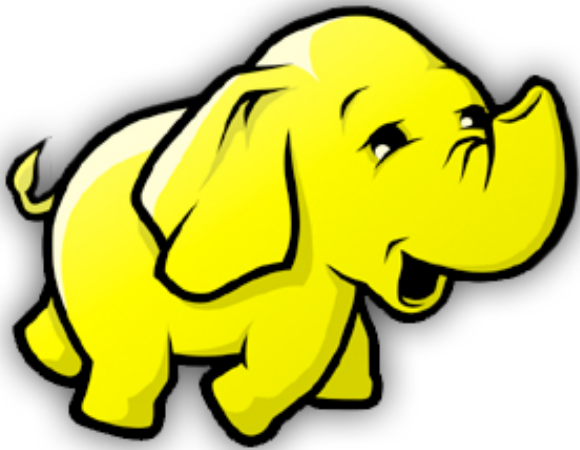
Older Workers...-> {1,1...}

Student digs -> 20,576

Reduced phase

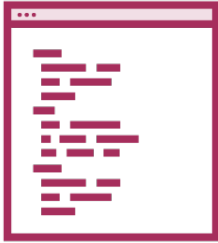
Merged input

Aggregated output



```
> hadoop jar streaming-x.y.z.jar
```





ENHANCED MAPREDUCE

- Using the distributed cache
- Adding a combiner
- Running multiple reducers
- Reporting counters



Older Workers...->1



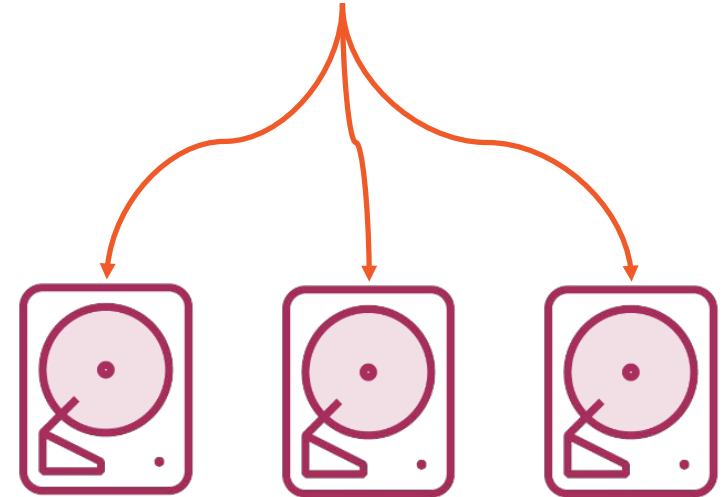
Older Workers...->1

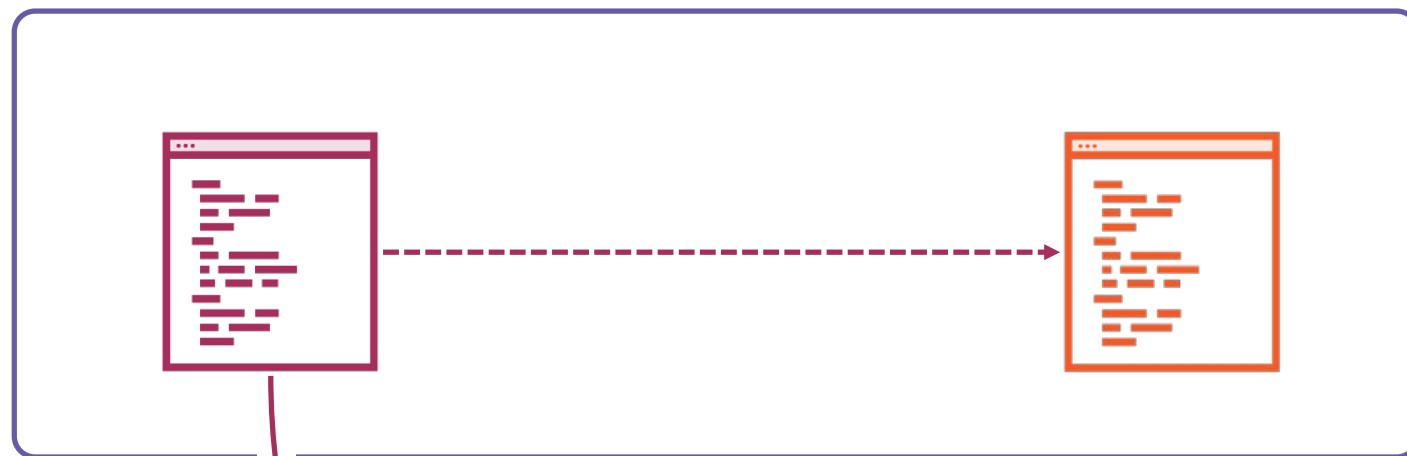


Older Workers...->1



Older Workers...->{1,1,1}

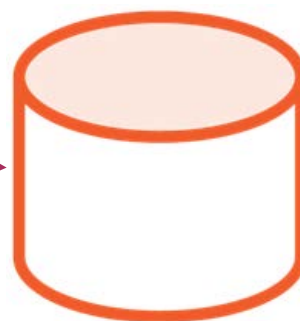


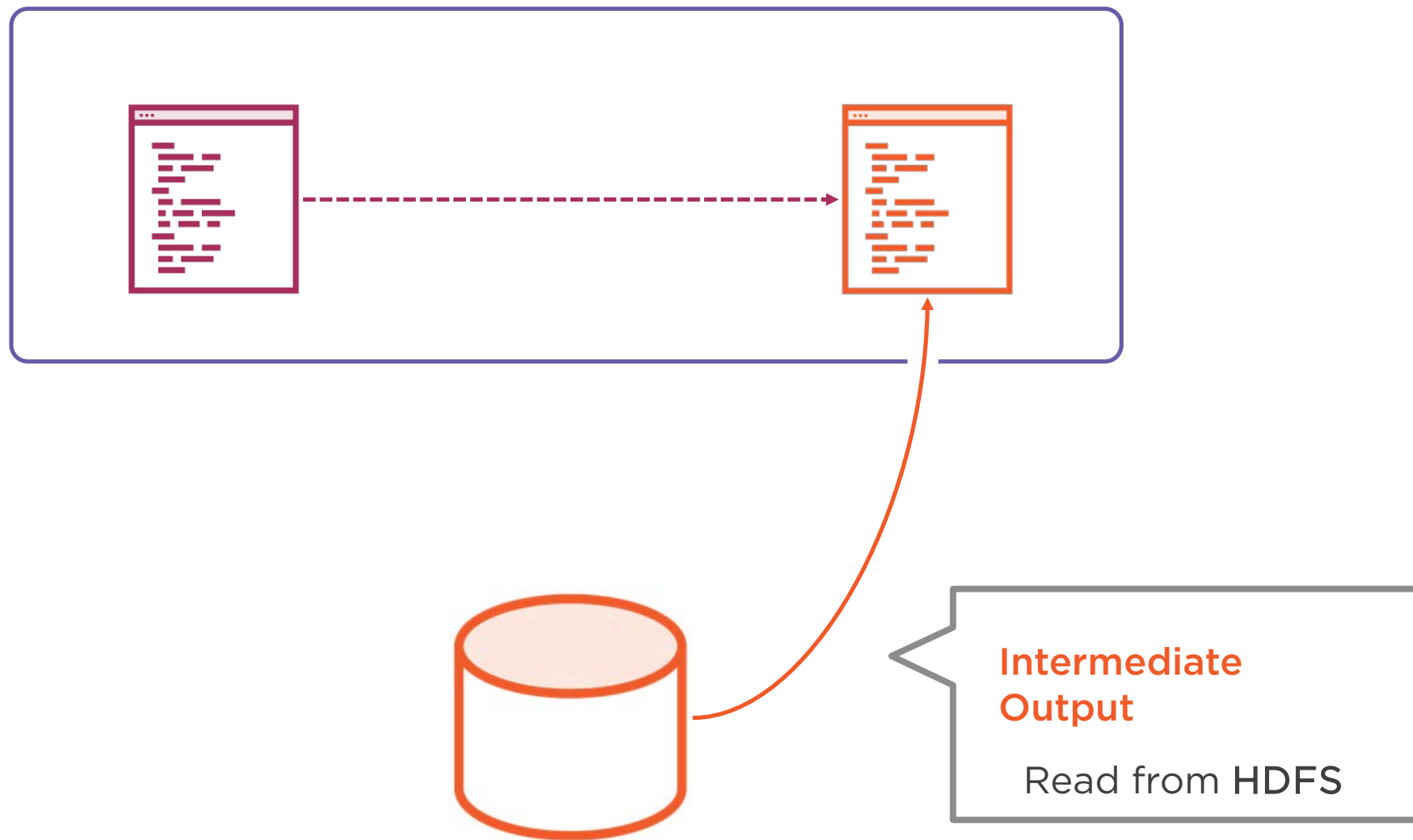


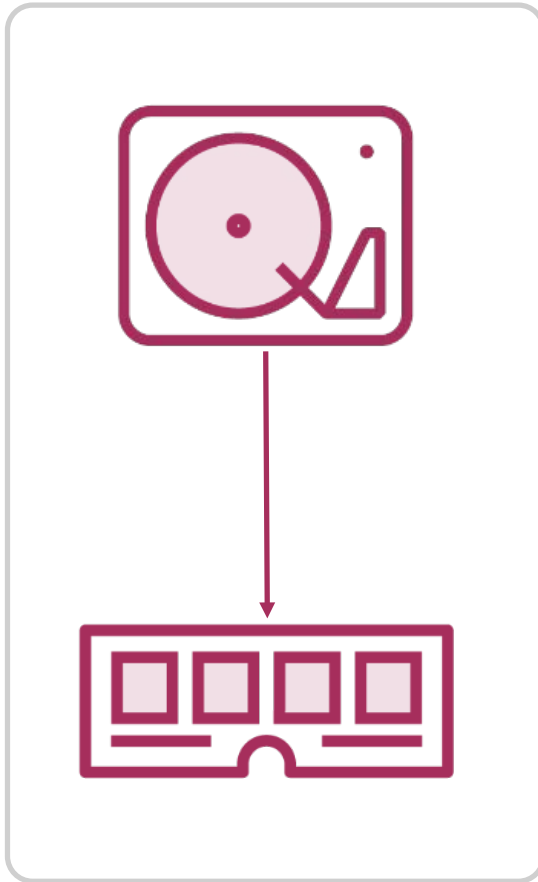
Intermediate Output

Written to HDFS

Distributed & replicated

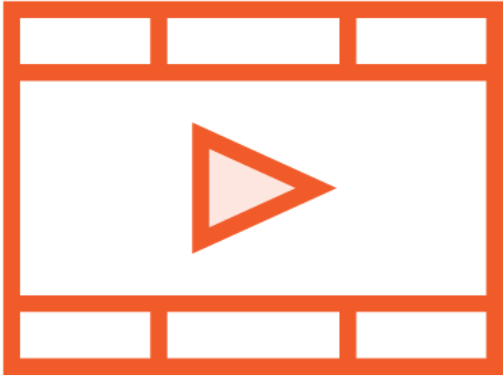






CACHE OPTIMIZATION

- Common data in-memory
- Memory read: 100ns
- SSD disk read: 100 μ s
- Network read: 100ms

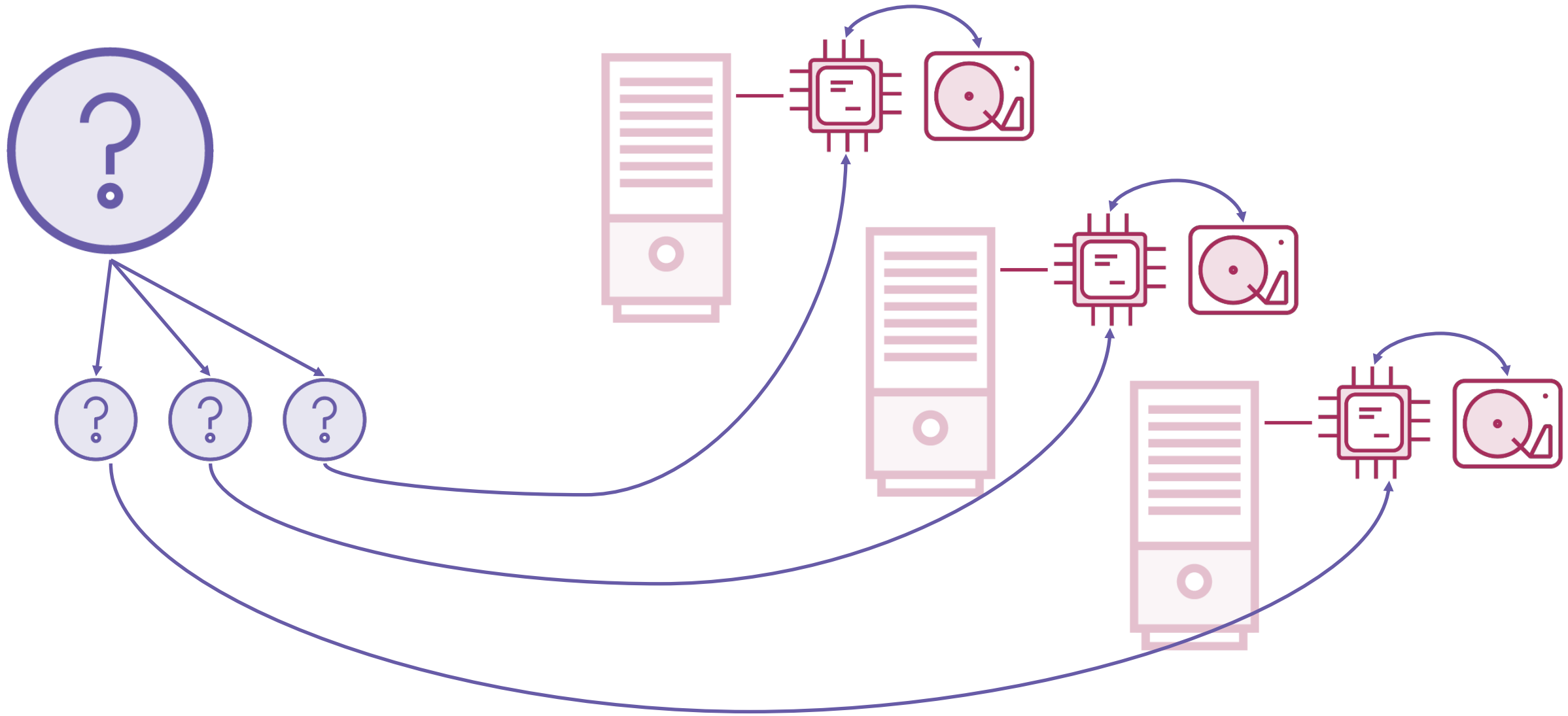


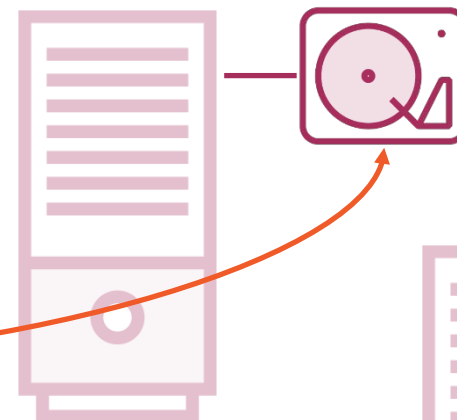
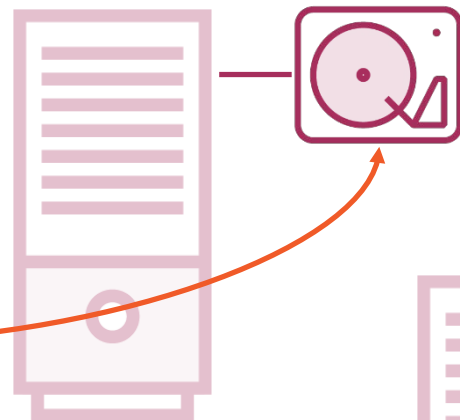
Caching in the .NET Stack: Inside Out



Elton Stoneman

@EltonStoneman blog.sixeyed.com





Distributed Cache
Ship reference
data




```
Job job = new Job();
```

```
job.addCacheFile(
```

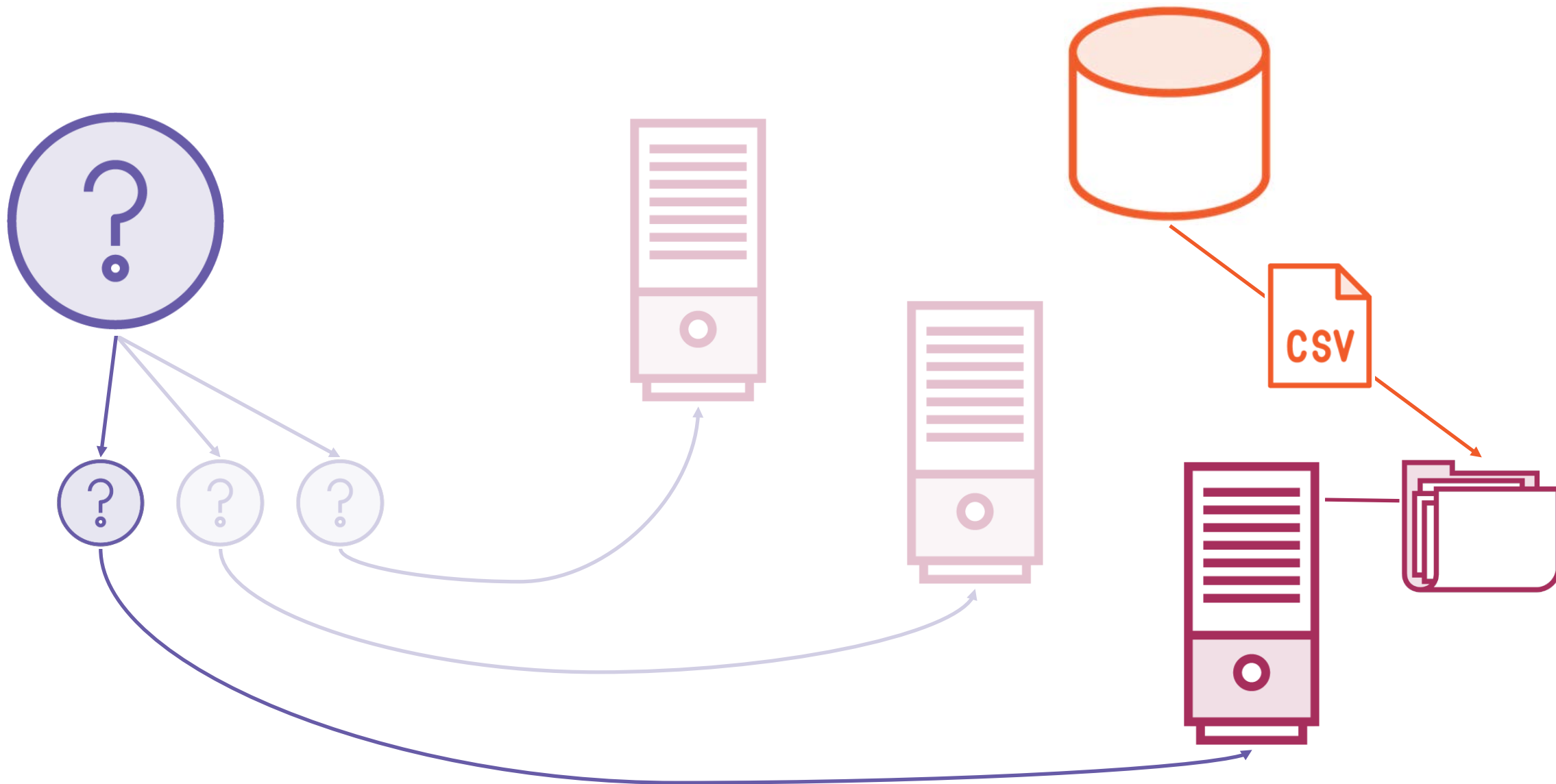
```
new Path("lookup.csv").toUri());
```

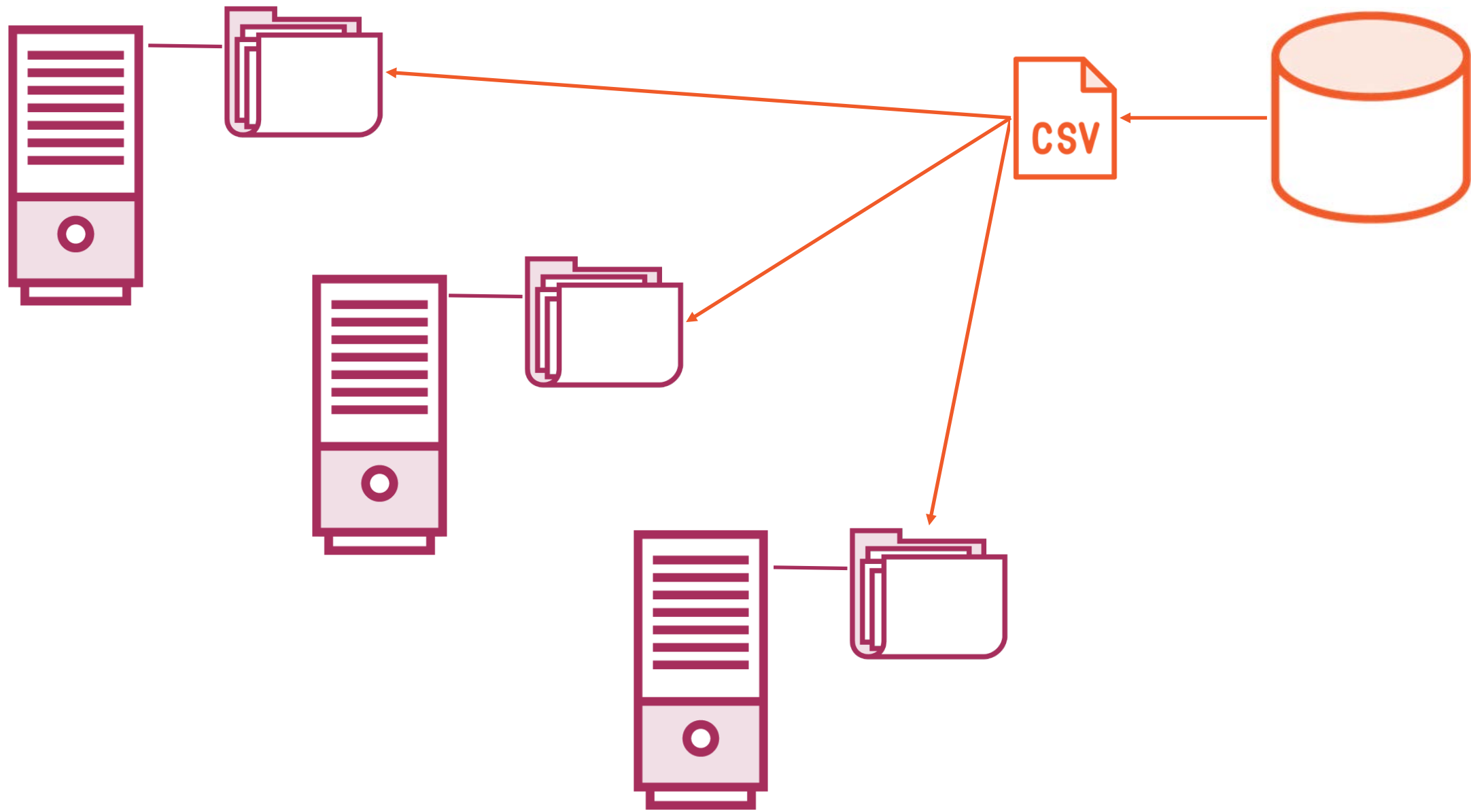
◀ Setup job

◀ Add to distributed
cache

◀ From local file path







hadoop jar

streaming-x.y.z.jar

-files ...

-archives ...

◀ **Submit a job**

◀ **Streaming JAR**

◀ **Files/directories to ship**

◀ **Compressed files to ship**

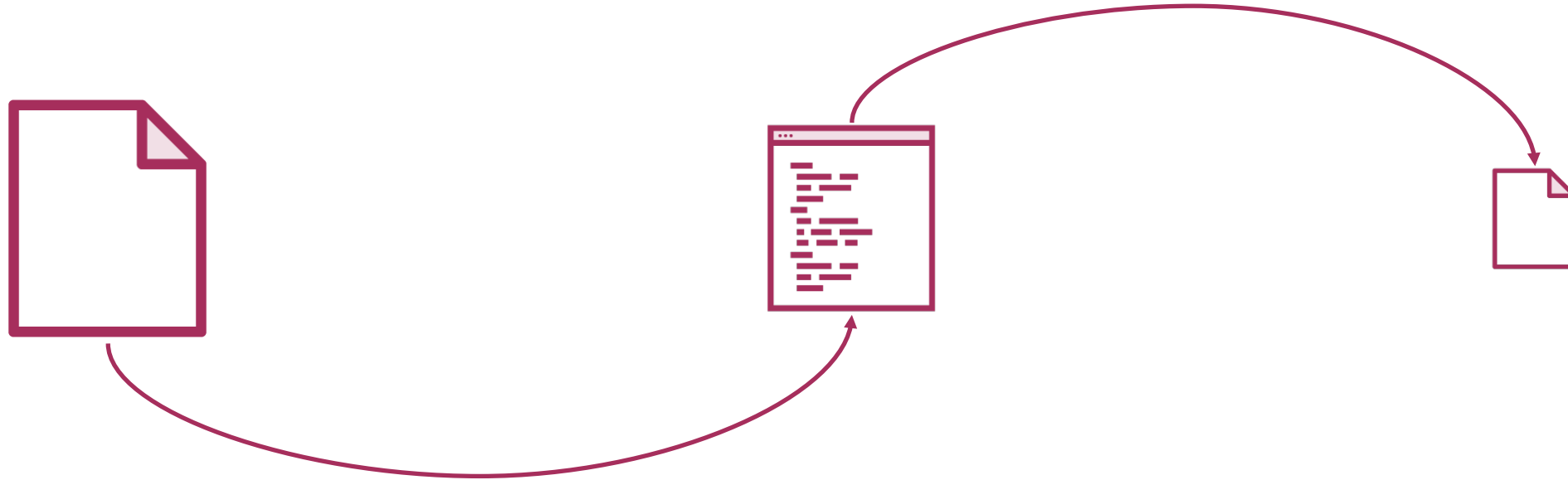
```
var lines =  
File.ReadAllLines(  
"refdata\\area-codes.csv");
```

◀ In reducer

◀ File access

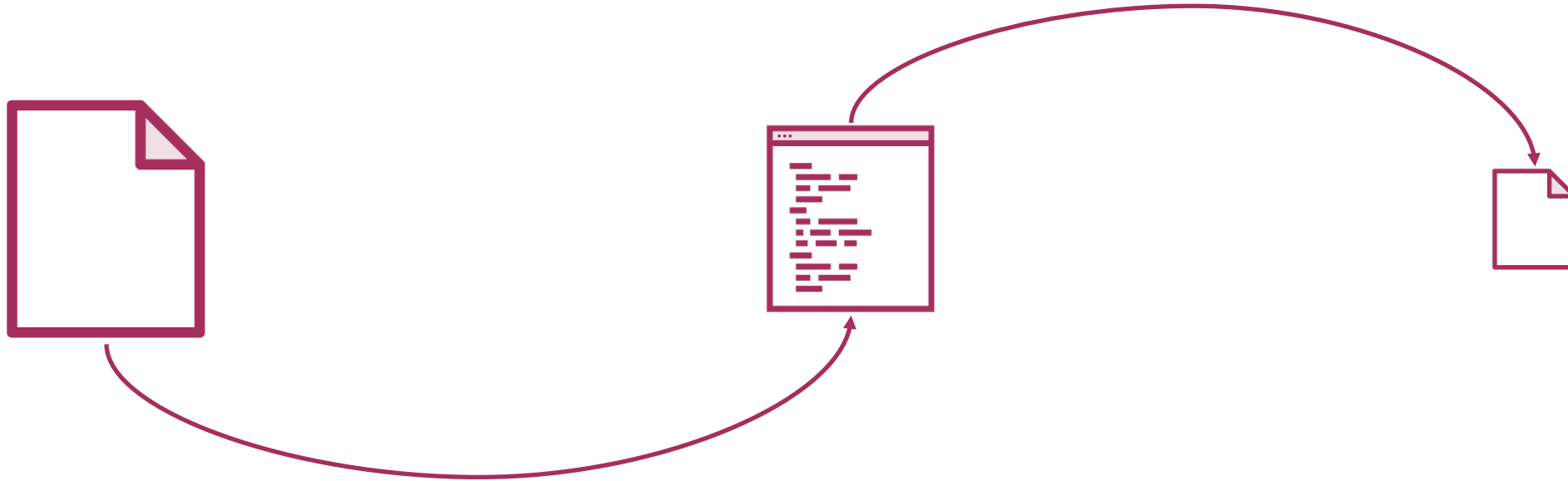
◀ Local file path

Older workers and retirement->1



TF4 3SN,TF4 3SN,TF4 3SN,10-
1985,0,368702,305526,1,E99999999,,E06000020,Telford and
Wrekin,E05009972,,E92000001,England,E12000005,West
Midlands,E14000989,Telford,E15000005,West Midlands,E16000071,Telford and
Wrekin,E01014123,Telford and Wrekin 019E,E02002946,Telford and Wrekin
019,6B4 Older workers and retirement -2.46402,52.64656,Postcode
Level,22/02/2016,"(52.64656, -2.46402)",1537688

6B4->1



TF4 3SN,TF4 3SN,TF4 3SN,10-
1985,0,368702,305526,1,E99999999,,E06000020,Telford and
Wrekin,E05009972,,E92000001,England,E12000005,West
Midlands,E14000989,Telford,E15000005,West Midlands,E16000071,Telford and
Wrekin,E01014123,Telford and Wrekin 019E,E02002946,Telford and Wrekin
019,6B4,Older workers and retirement,-2.46402,52.64656,Postcode
Level,22/02/2016,"(52.64656, -2.46402)",1537688



6B4->1

6B4->1

6B4->1

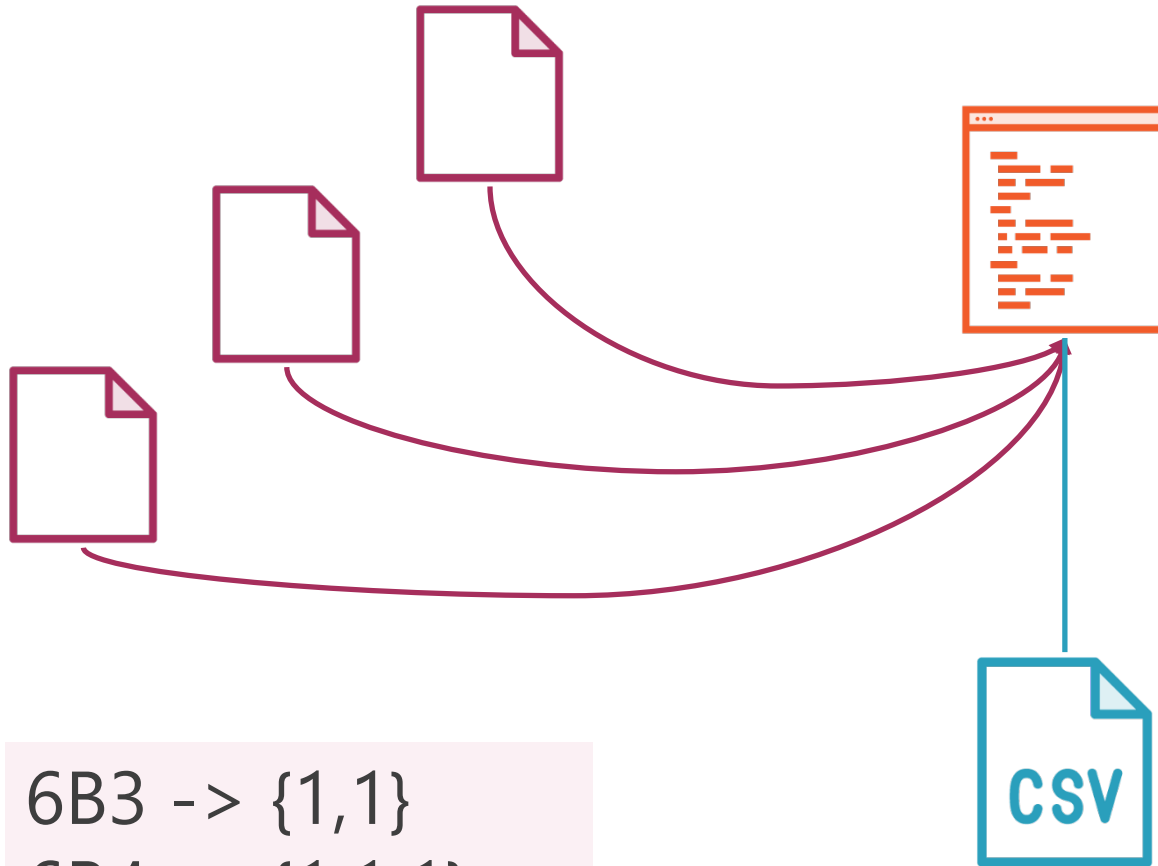


6B4->{1,1,1}

Map phase

Optimized output

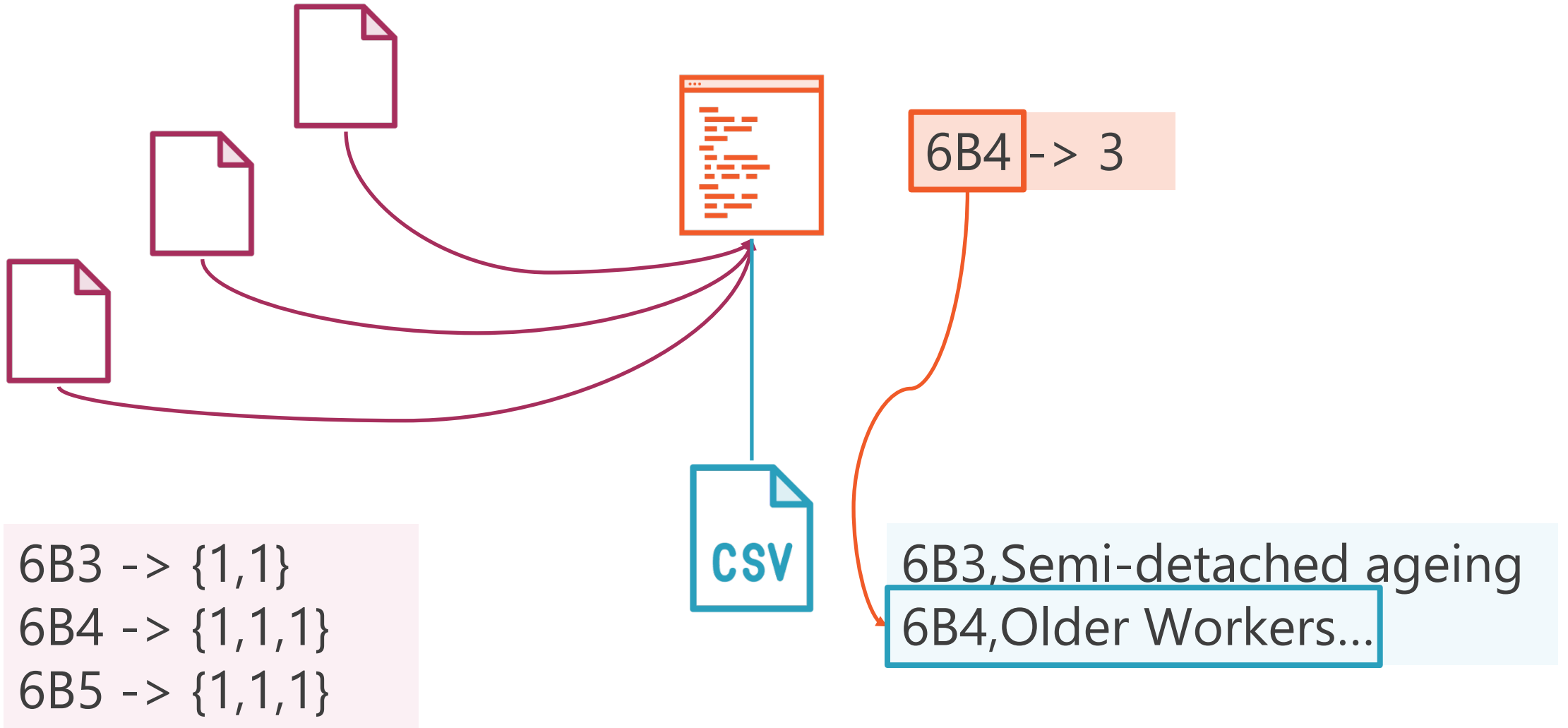
Faster to **write** and **read**

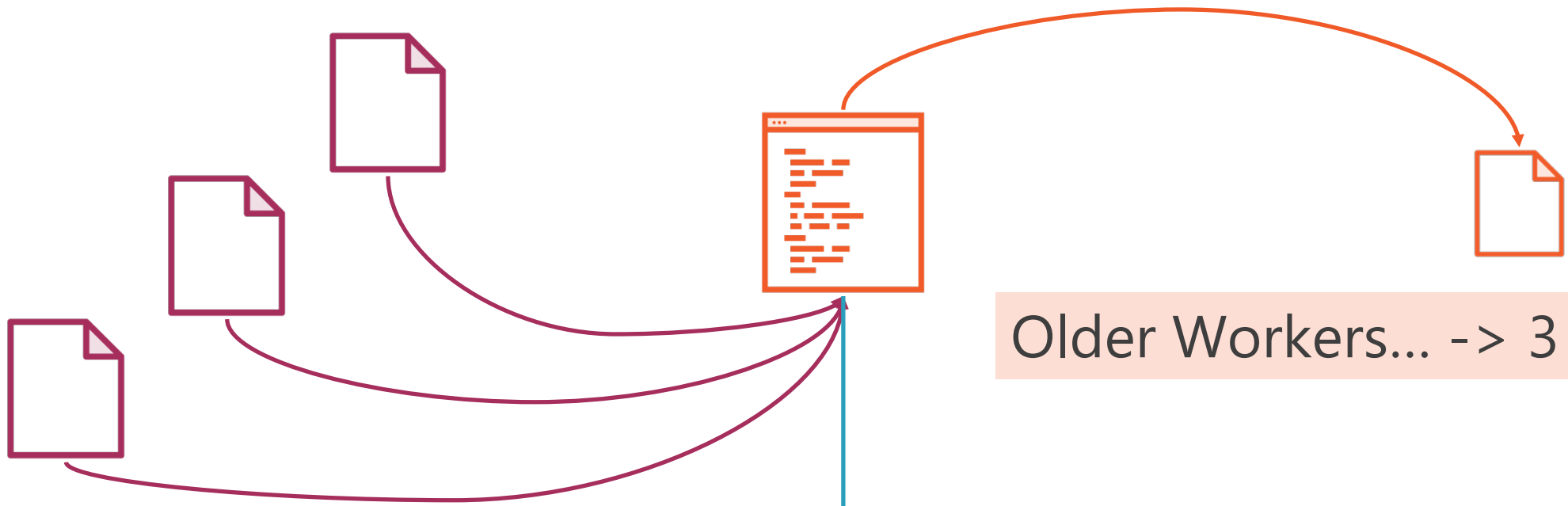


6B3 -> {1,1}
6B4 -> {1,1,1}
6B5 -> {1,1,1}

6B4 -> 3

6B3, Semi-detached ageing
6B4, Older Workers...



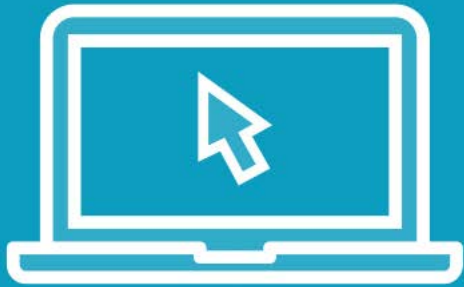


6B3 -> {1,1}
6B4 -> {1,1,1}
6B5 -> {1,1,1}

Older Workers... -> 3

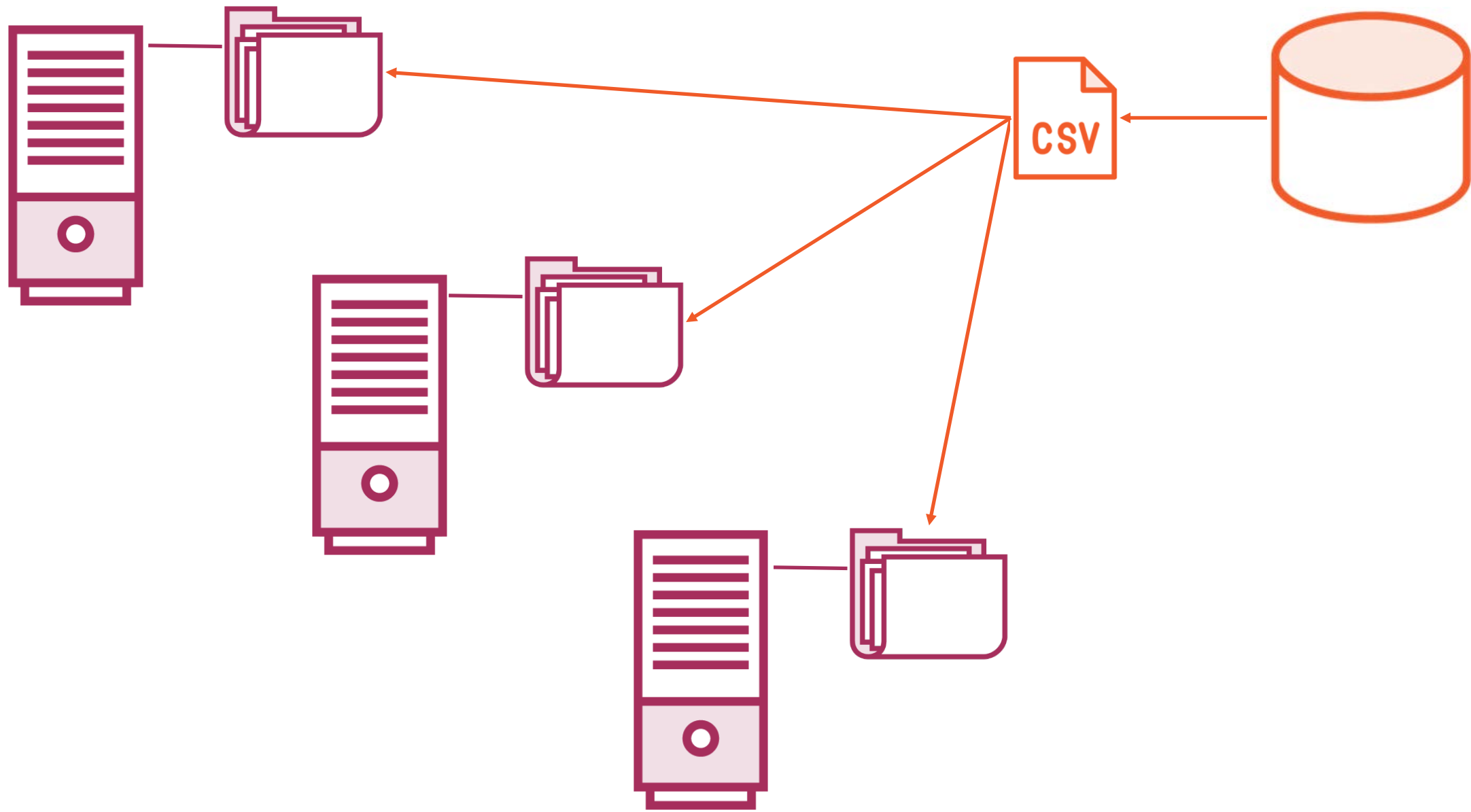
6B3, Semi-detached ageing
6B4, Older Workers...

Demo

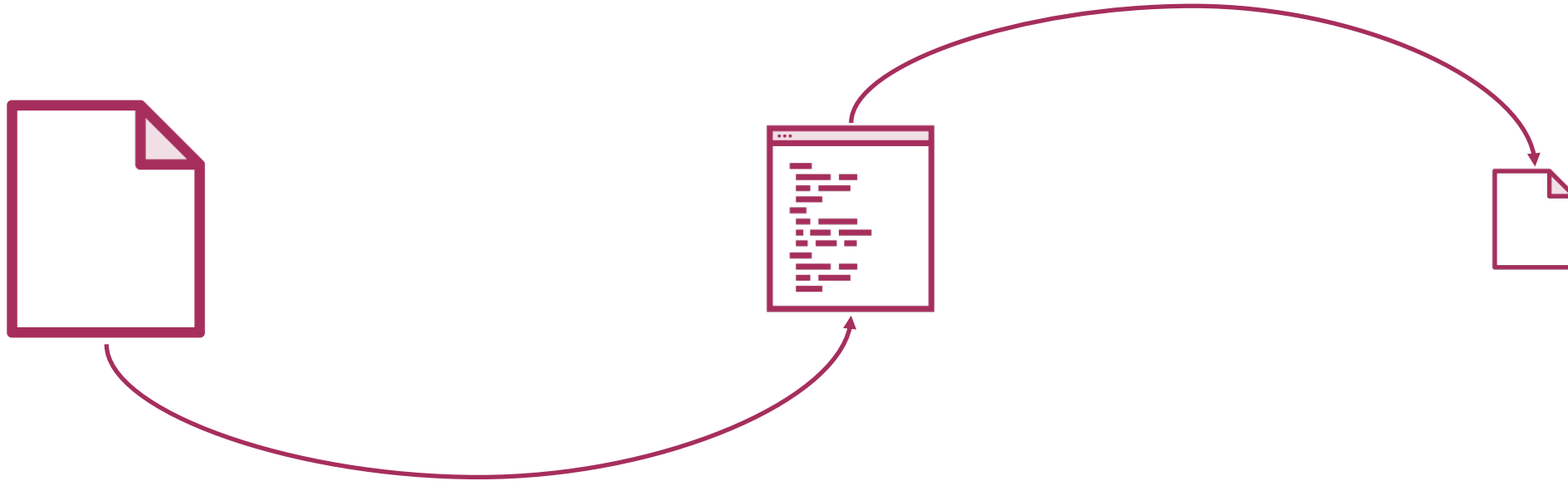


Using the Distributed Cache

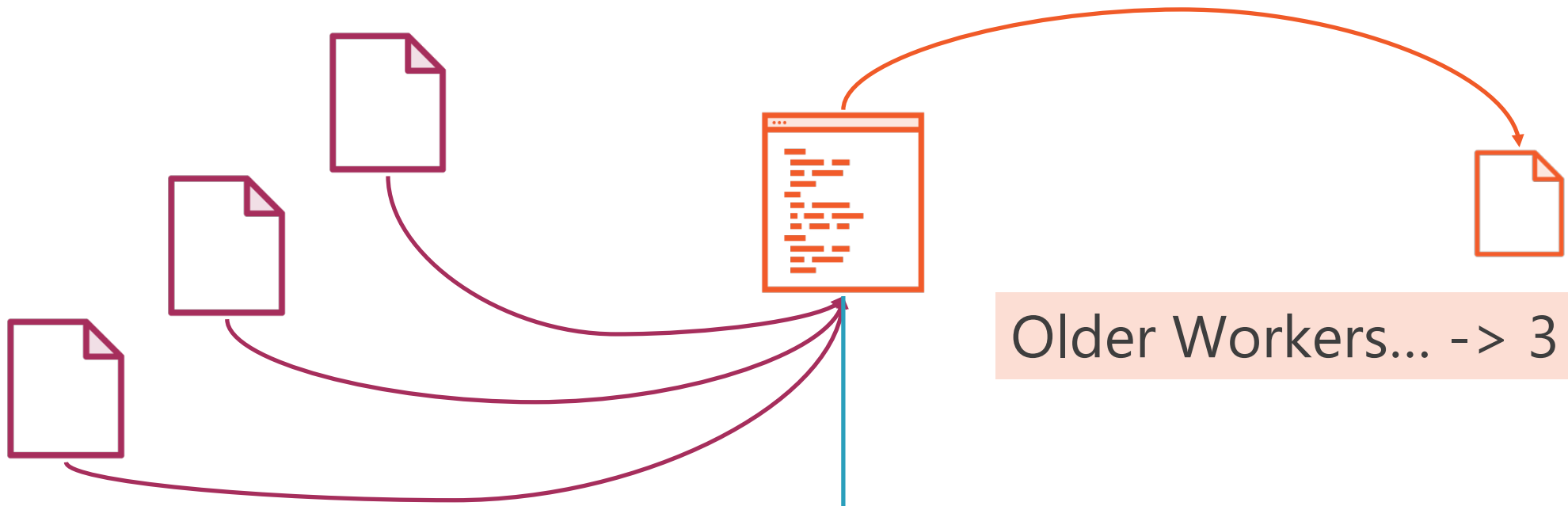
- Shipping reference data
- Optimizing intermediate output
- Lookup final output



6B4->1



TF4 3SN,TF4 3SN,TF4 3SN,10-
1985,0,368702,305526,1,E99999999,,E06000020,Telford and
Wrekin,E05009972,,E92000001,England,E12000005,West
Midlands,E14000989,Telford,E15000005,West Midlands,E16000071,Telford and
Wrekin,E01014123,Telford and Wrekin 019E,E02002946,Telford and Wrekin
019,6B4,Older workers and retirement,-2.46402,52.64656,Postcode
Level,22/02/2016,"(52.64656, -2.46402)",1537688



Older Workers... -> 3

6B3 -> {1,1}
6B4 -> {1,1,1}
6B5 -> {1,1,1}

6B3,Semi-detached ageing
6B4,Older Workers...



Rural white-collar workers->1



Rural white-collar workers->1



Rural white-collar workers->1



x70,876



1B2->1



1B2->1

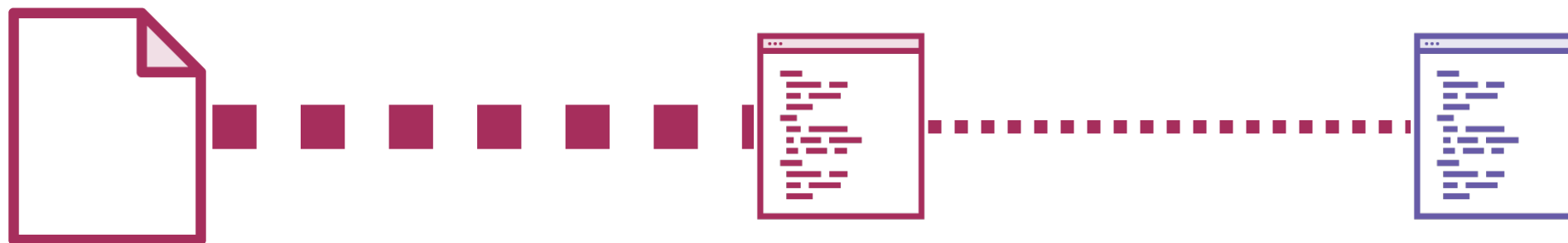


1B2->1



x70,876

Combiner
Mini reducer

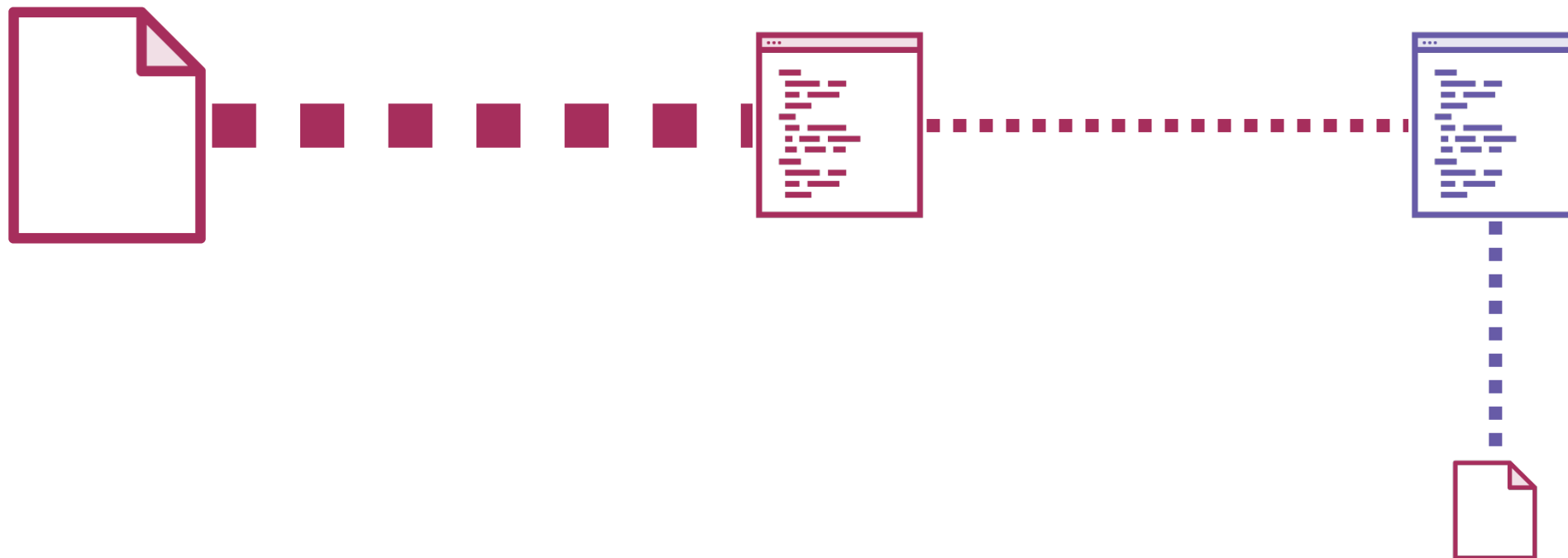


6B4- > 1

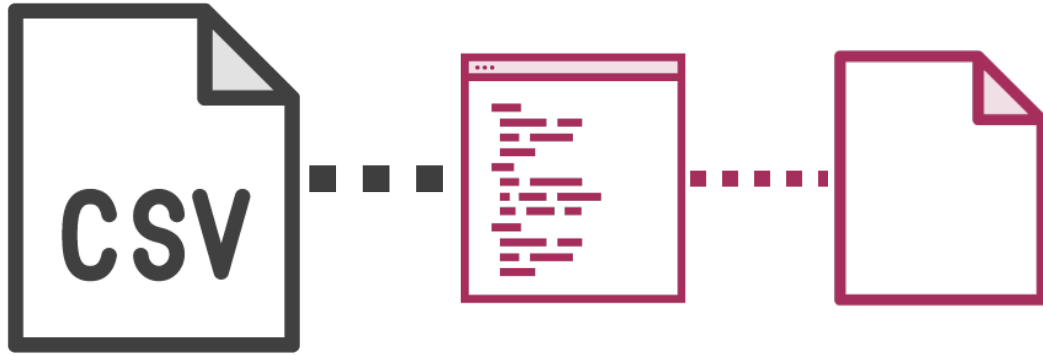
6B4- > 1

6B4- > 1

Combiner
Mini reducer

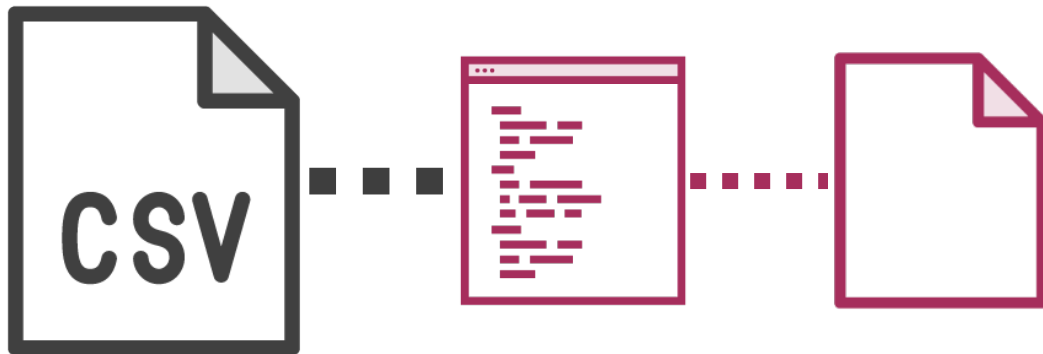


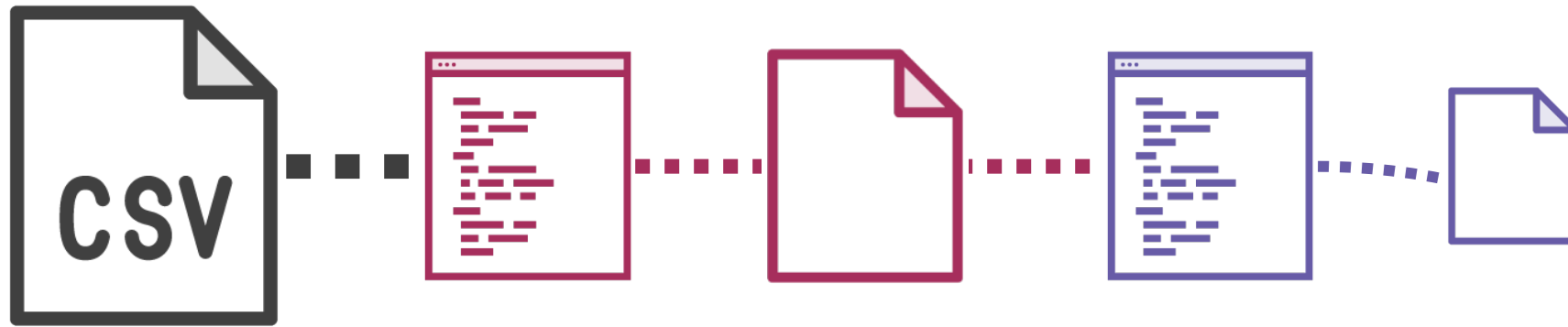
6B4->3



x5

Mapper
1 per file block

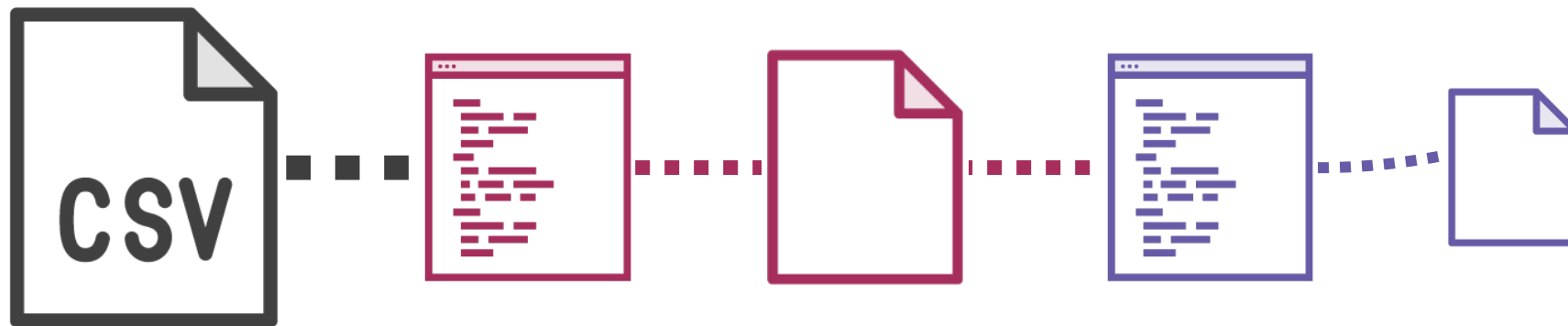


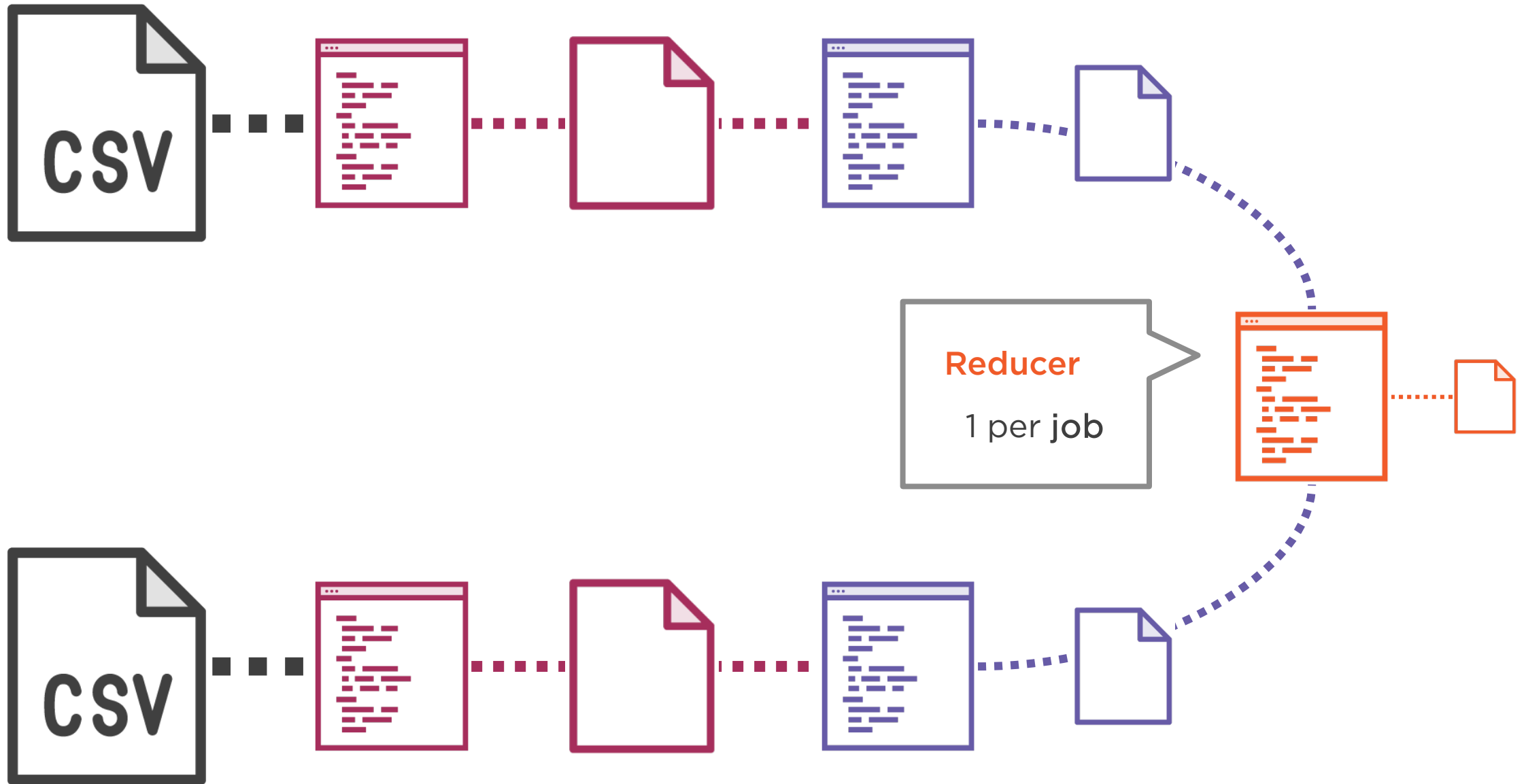


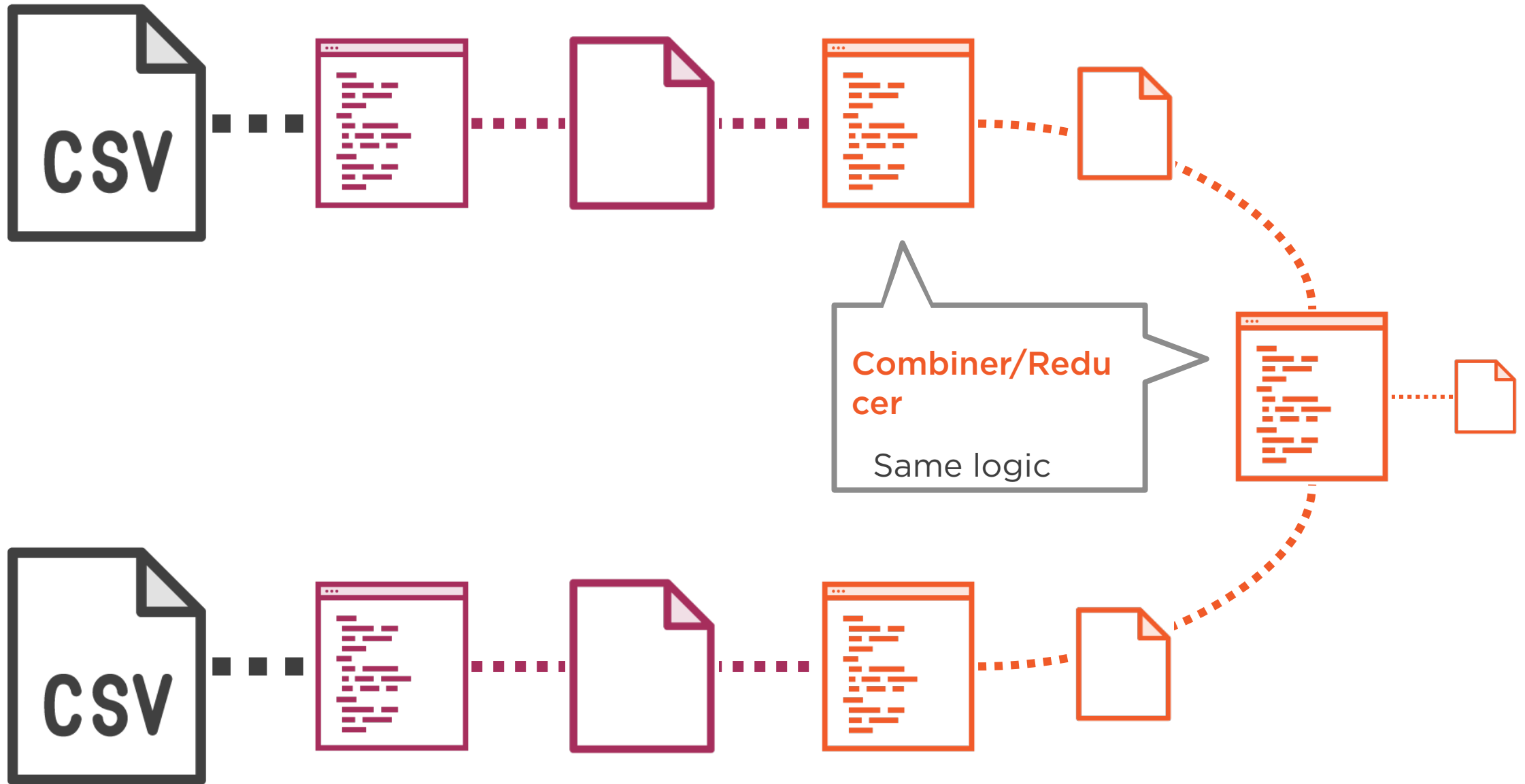
x5

Combiner

1 per mapper







hadoop jar

streaming-x.y.z.jar

-files ...

-mapper ...

-reducer ...

-combiner ...

◀ **Submit a job**

◀ **Streaming JAR**

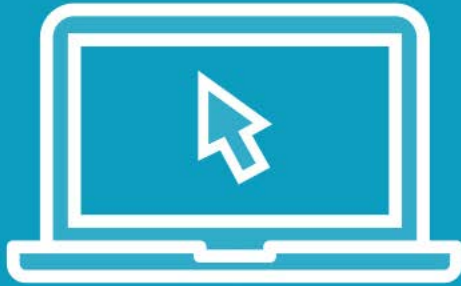
◀ **Files to ship**

◀ **Mapper command**

◀ **Reducer command**

◀ **Combiner command**

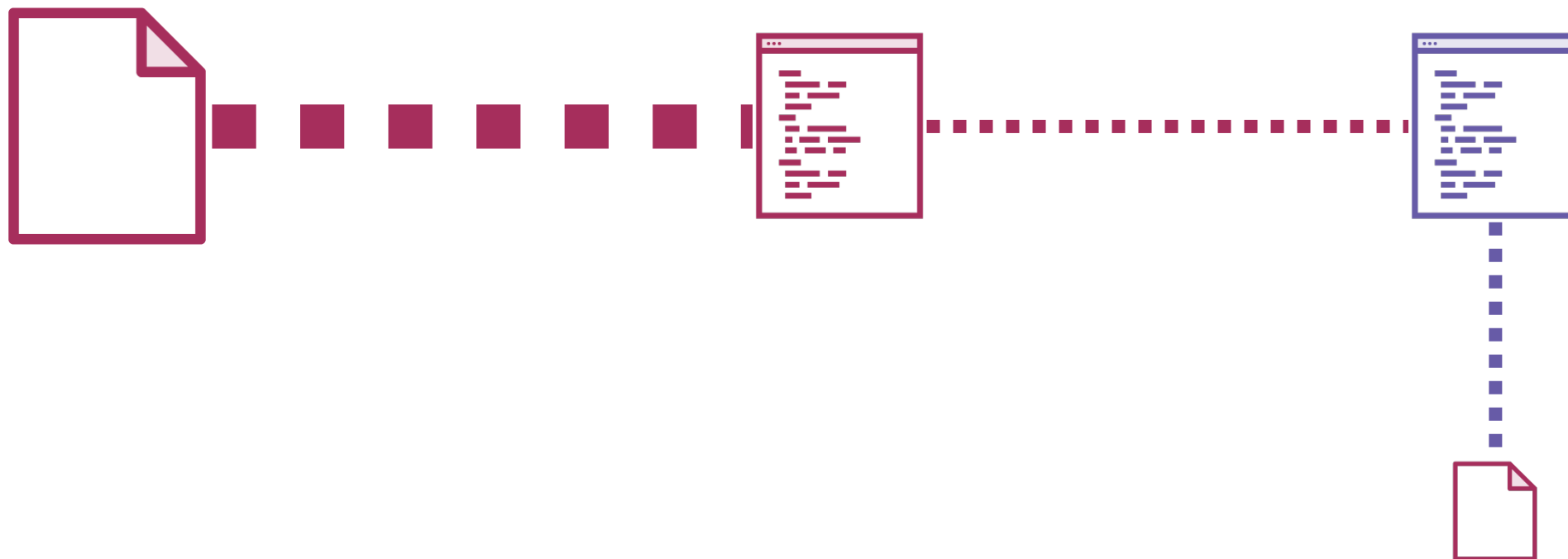
Demo



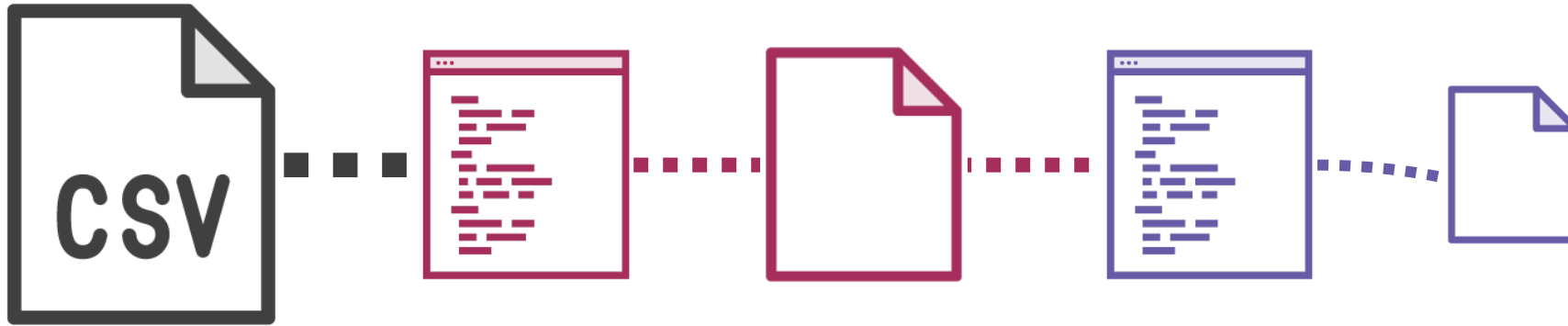
Streaming with a Combiner

- .NET combiner
- Shipped with dependencies
- Running with Hadoop Streaming

Combiner
Mini reducer

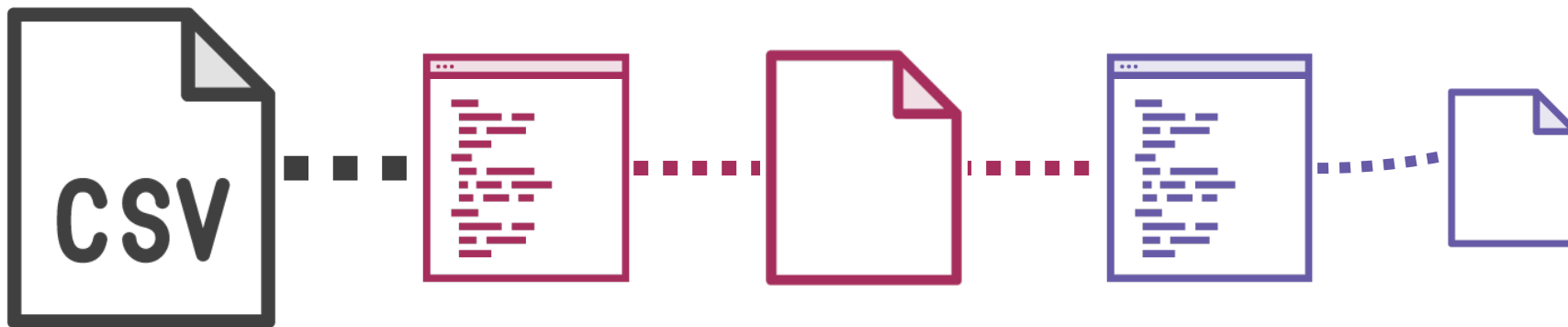


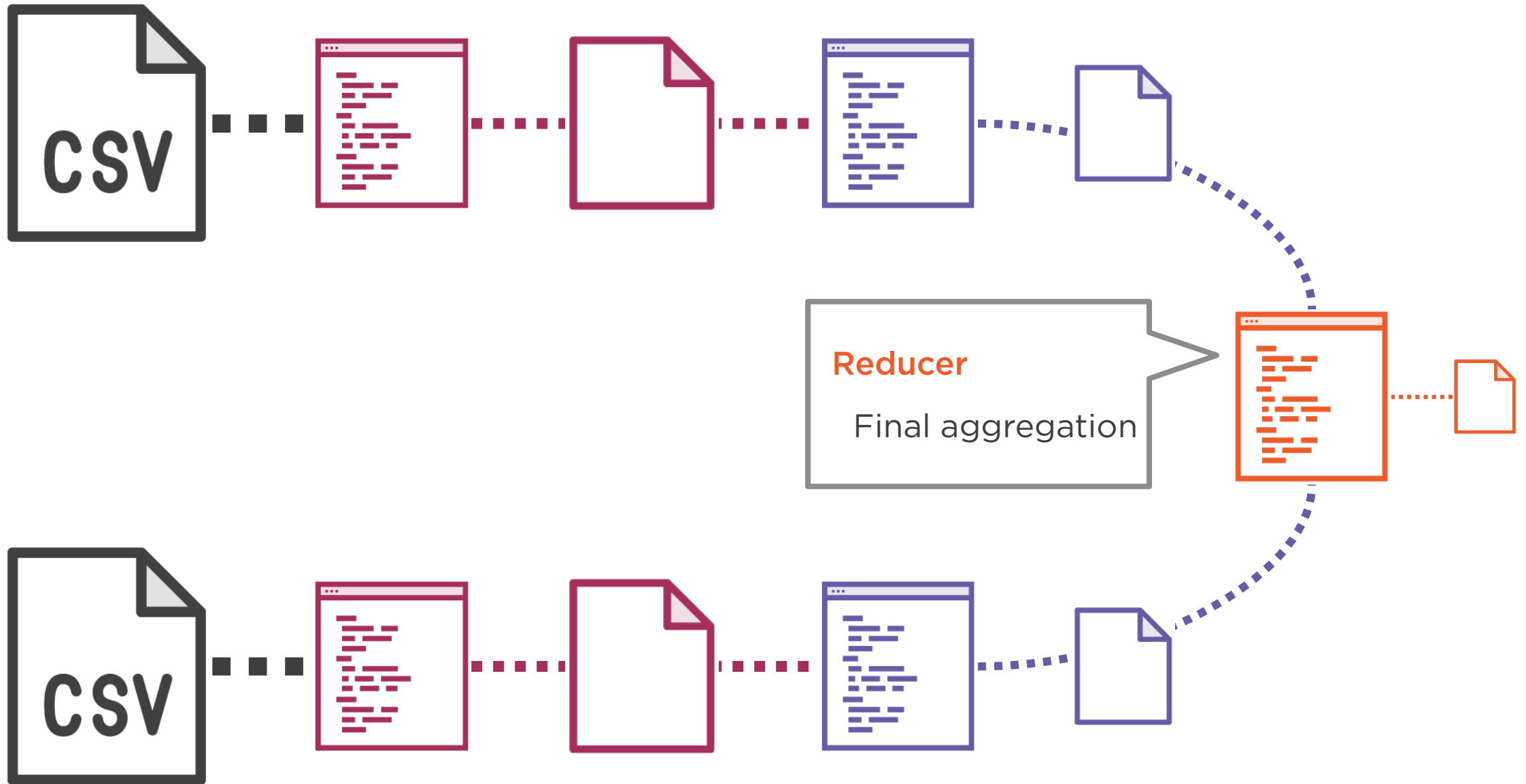
6B4->3

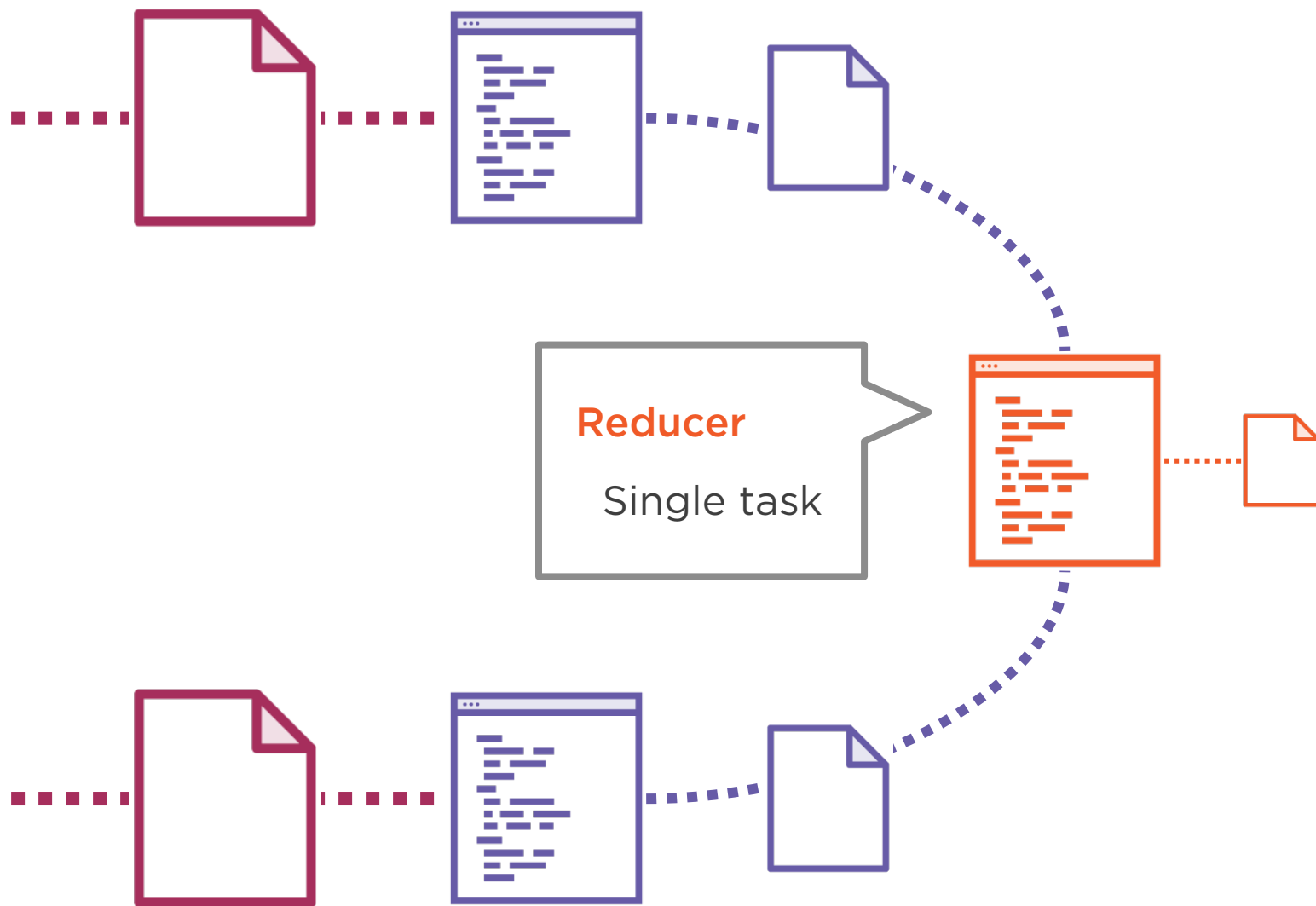


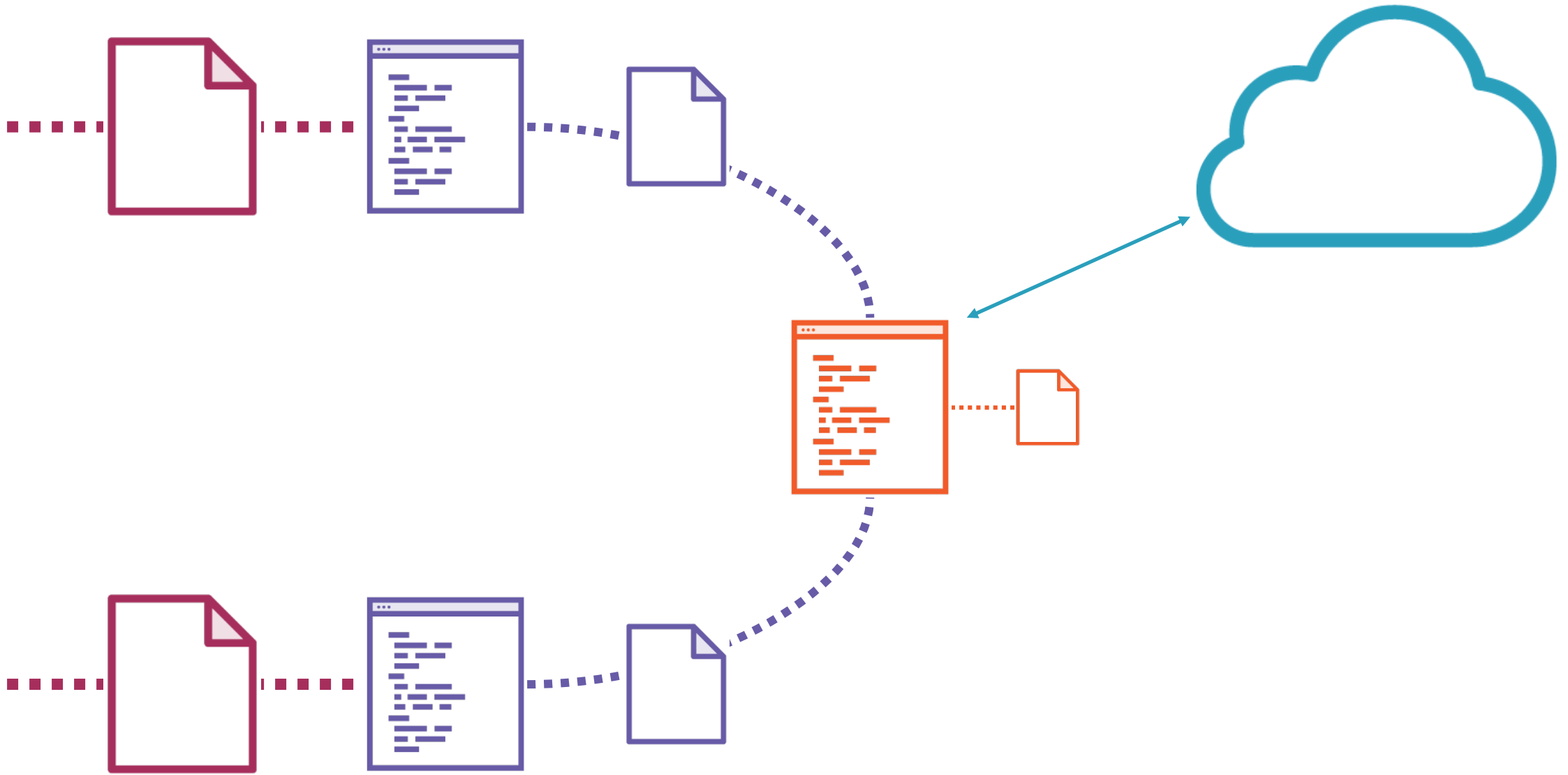
Combiner

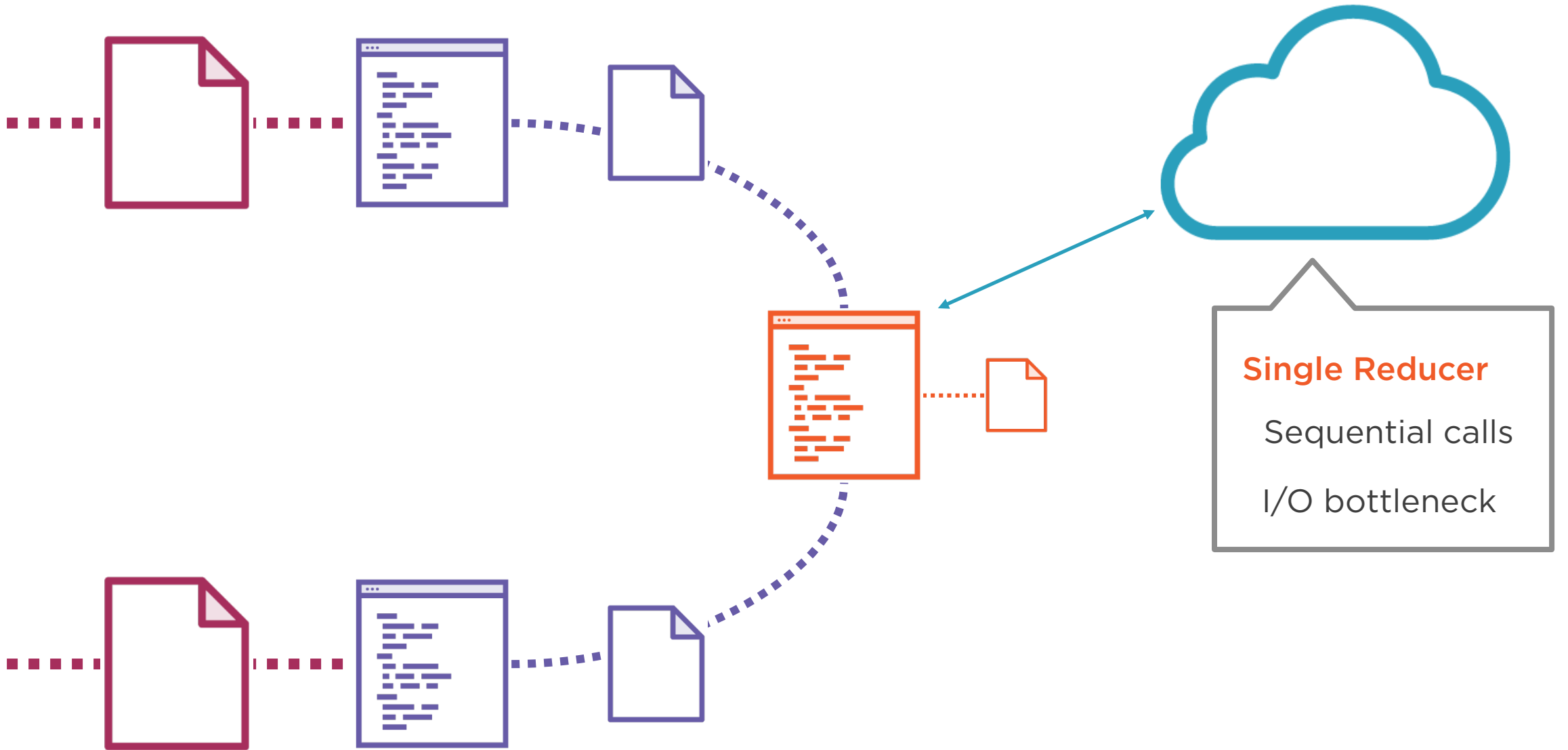
Initial aggregation

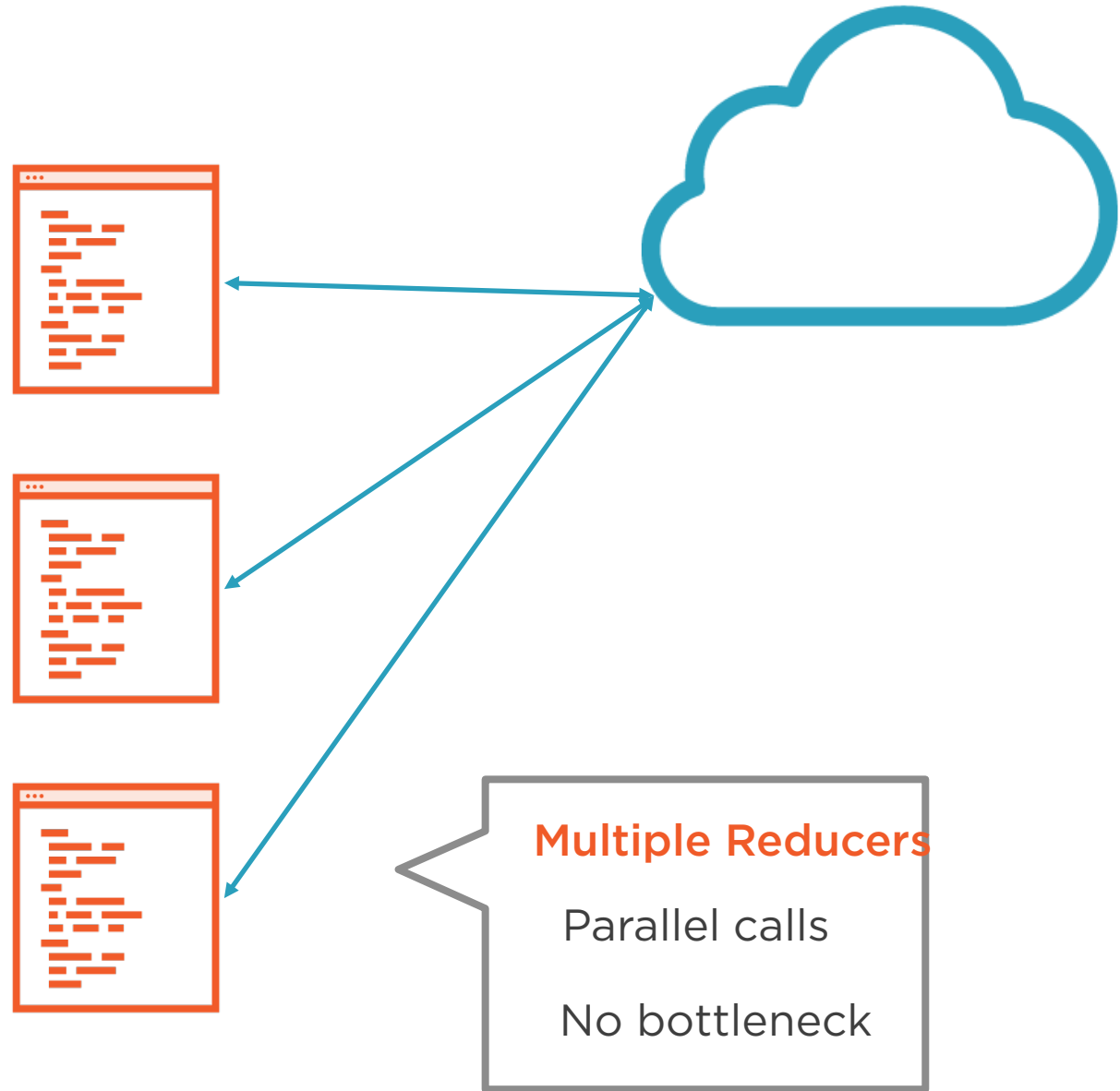








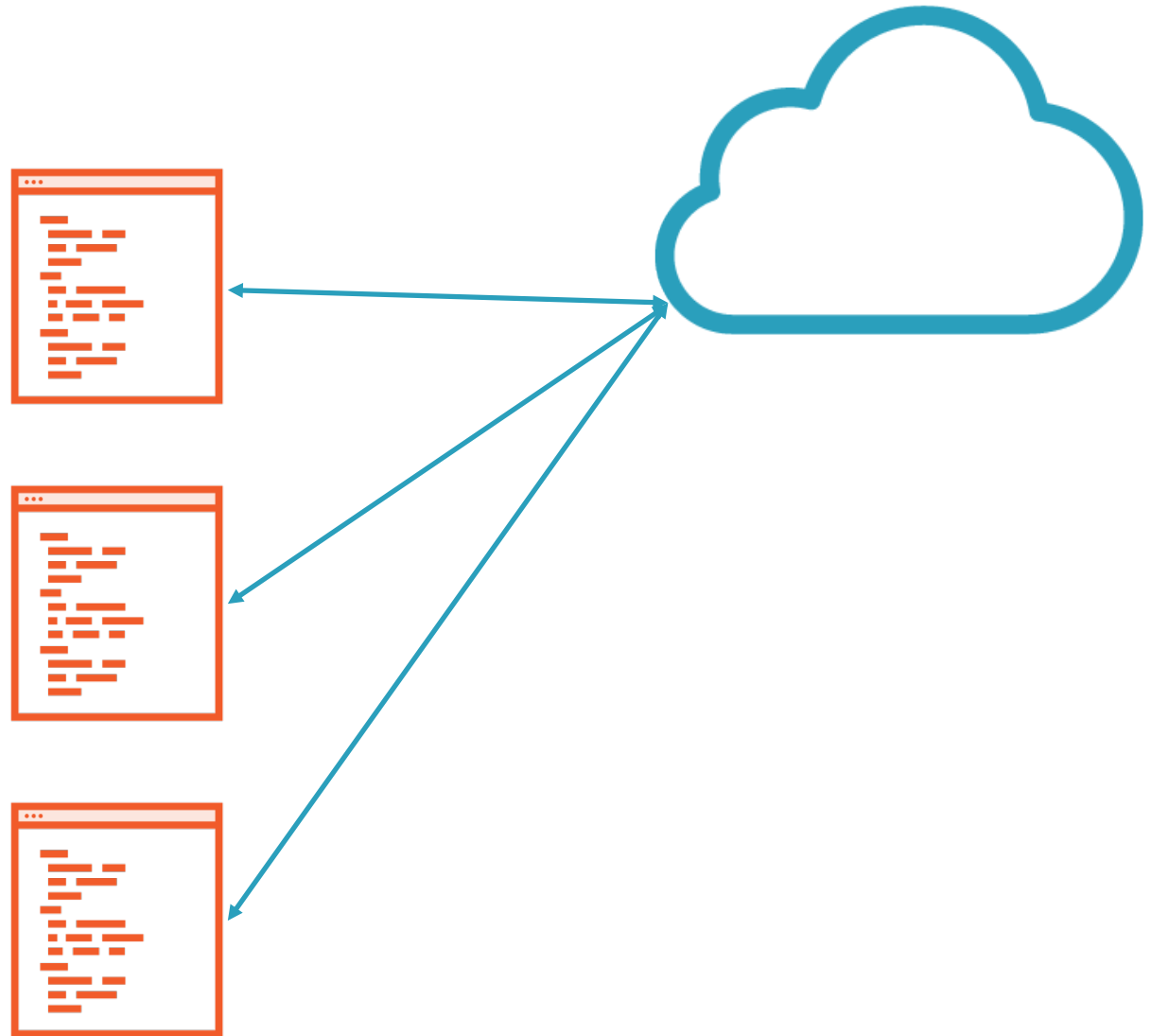


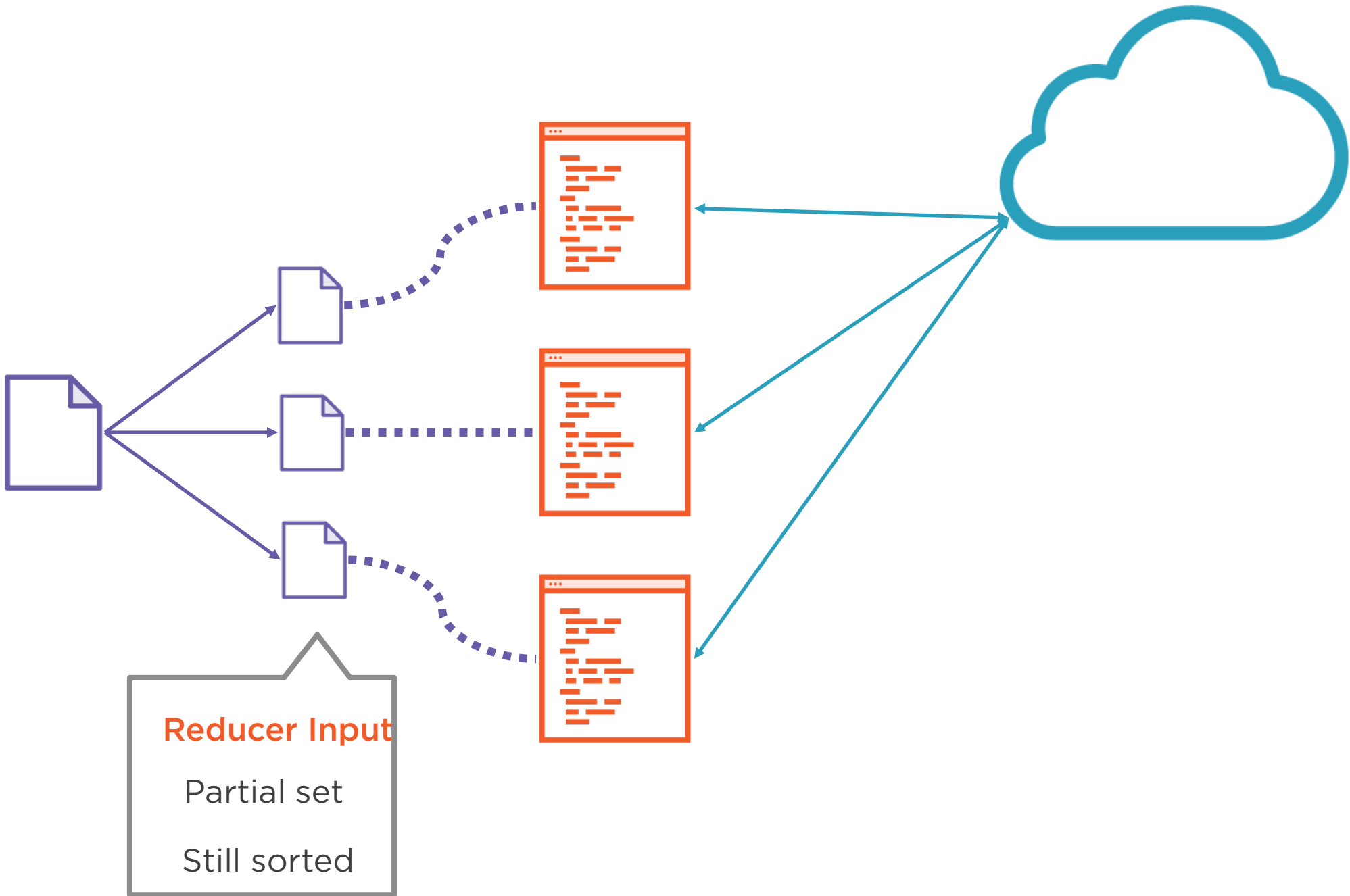


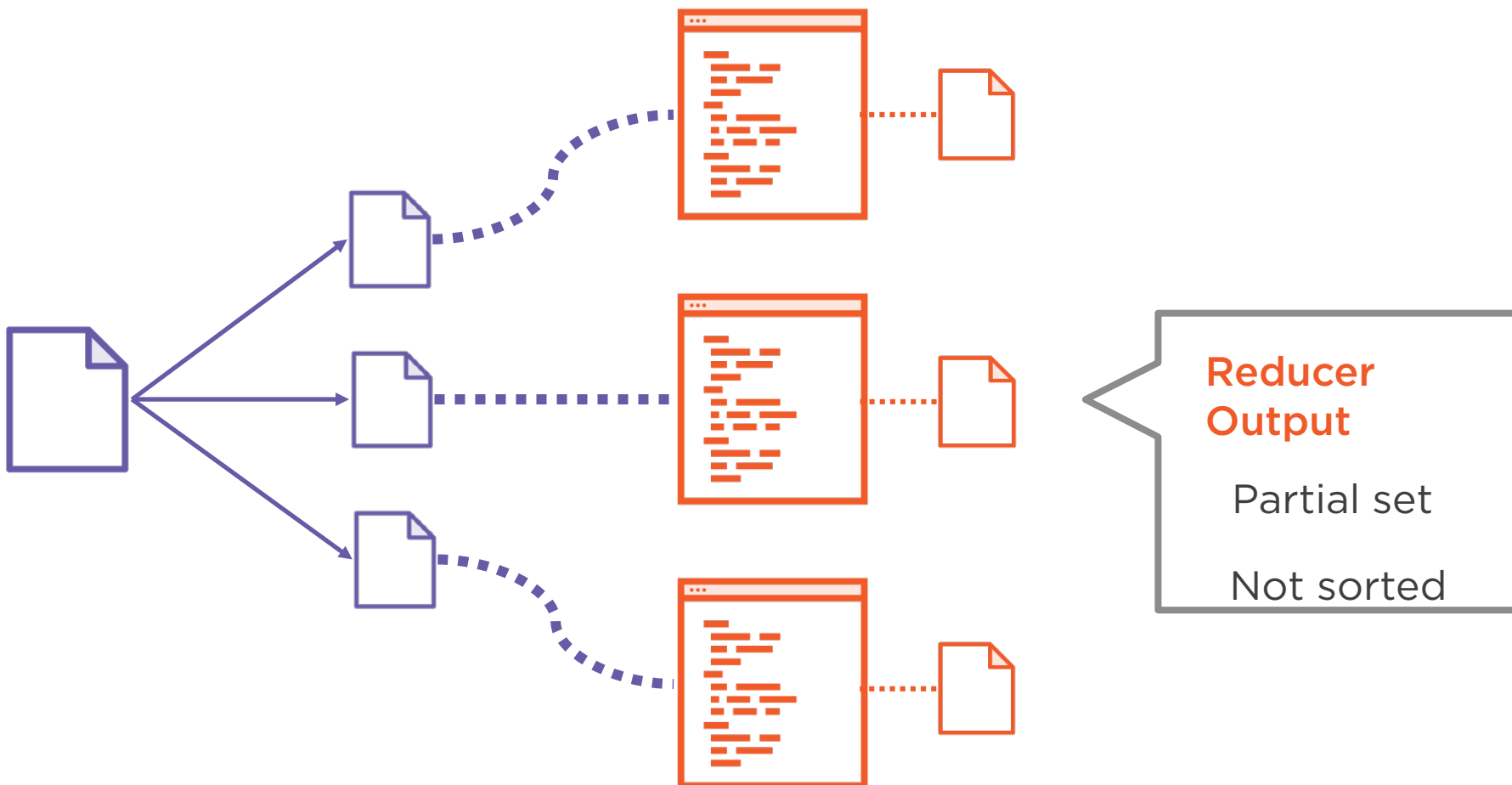
**Intermediate
Output**

Merged

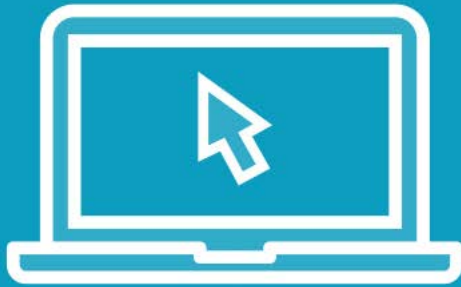
Sorted





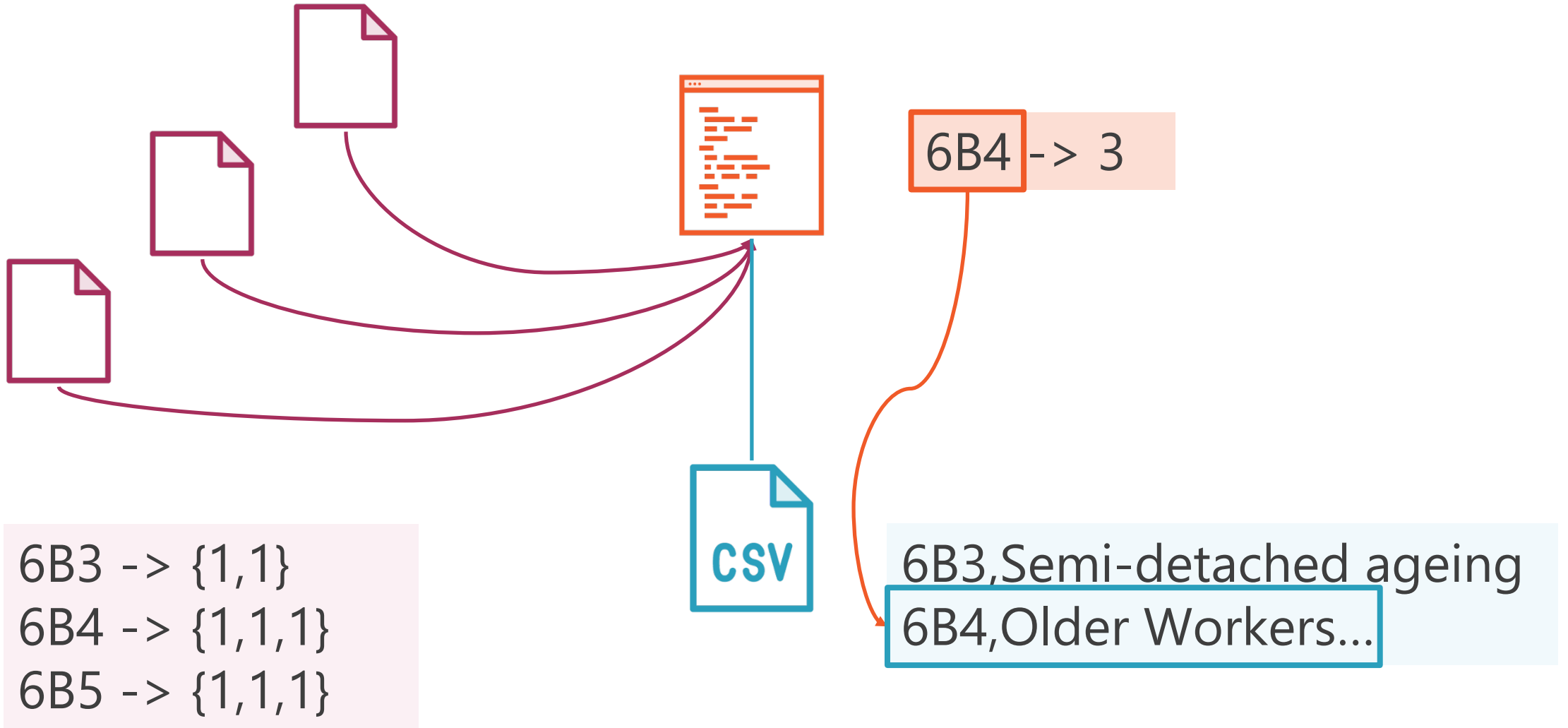


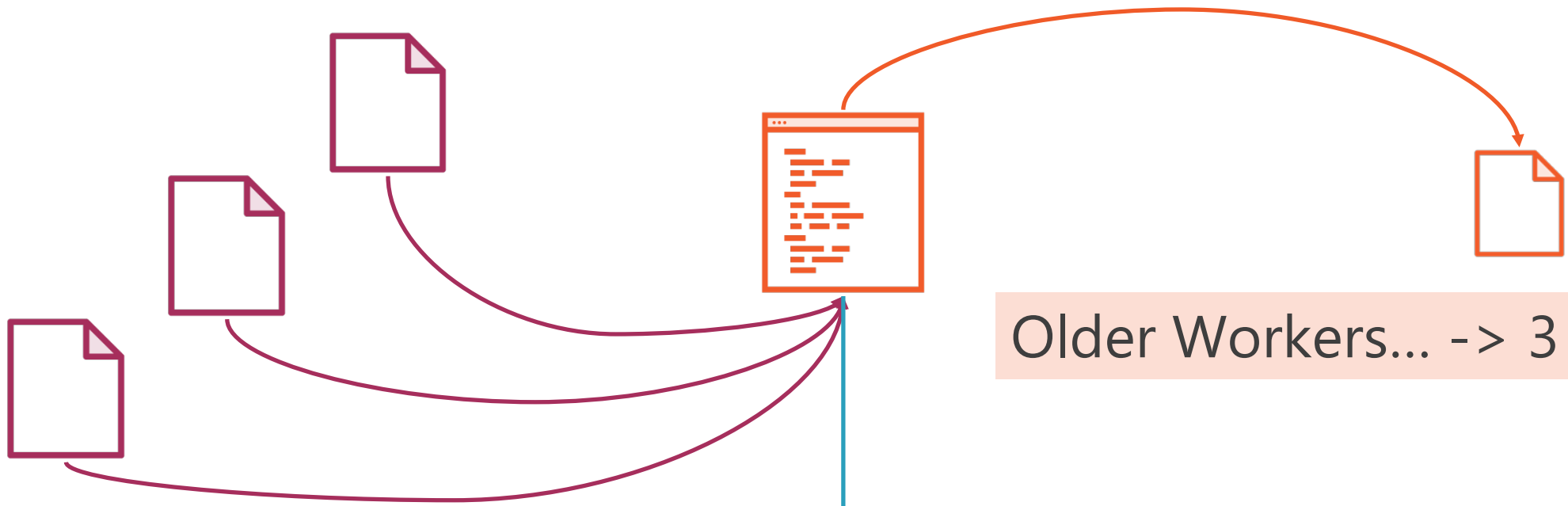
Demo



Multiple Reducers

- Hadoop job configuration
- Multiple output files
- Compressing mapper output

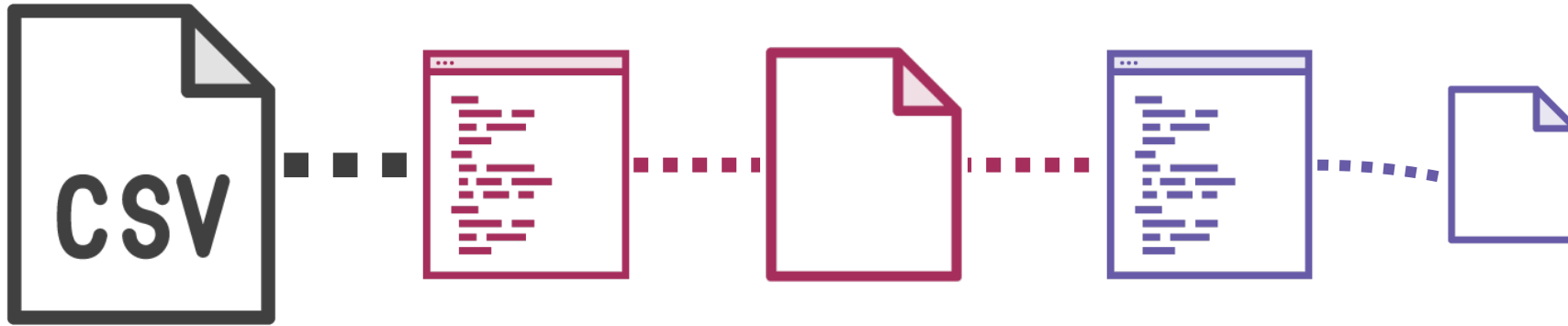




Older Workers... -> 3

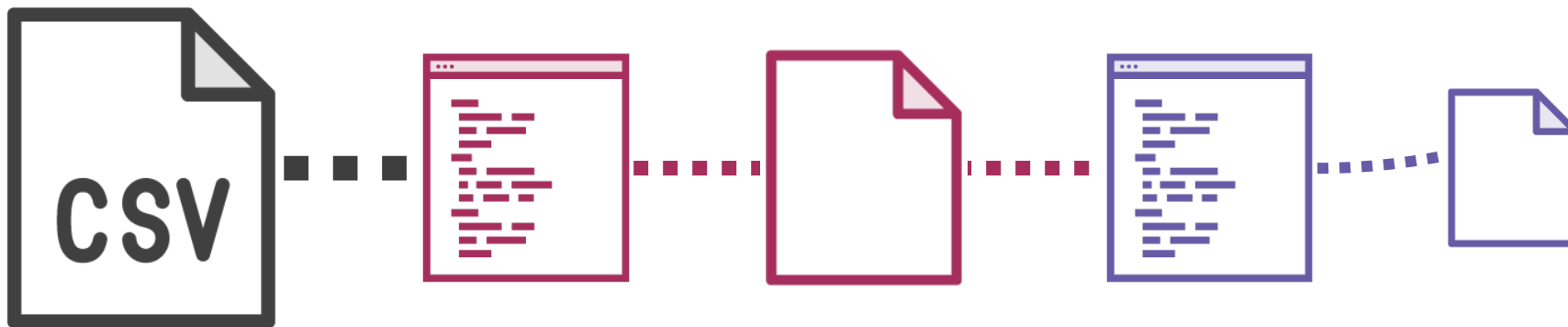
6B3 -> {1,1}
6B4 -> {1,1,1}
6B5 -> {1,1,1}

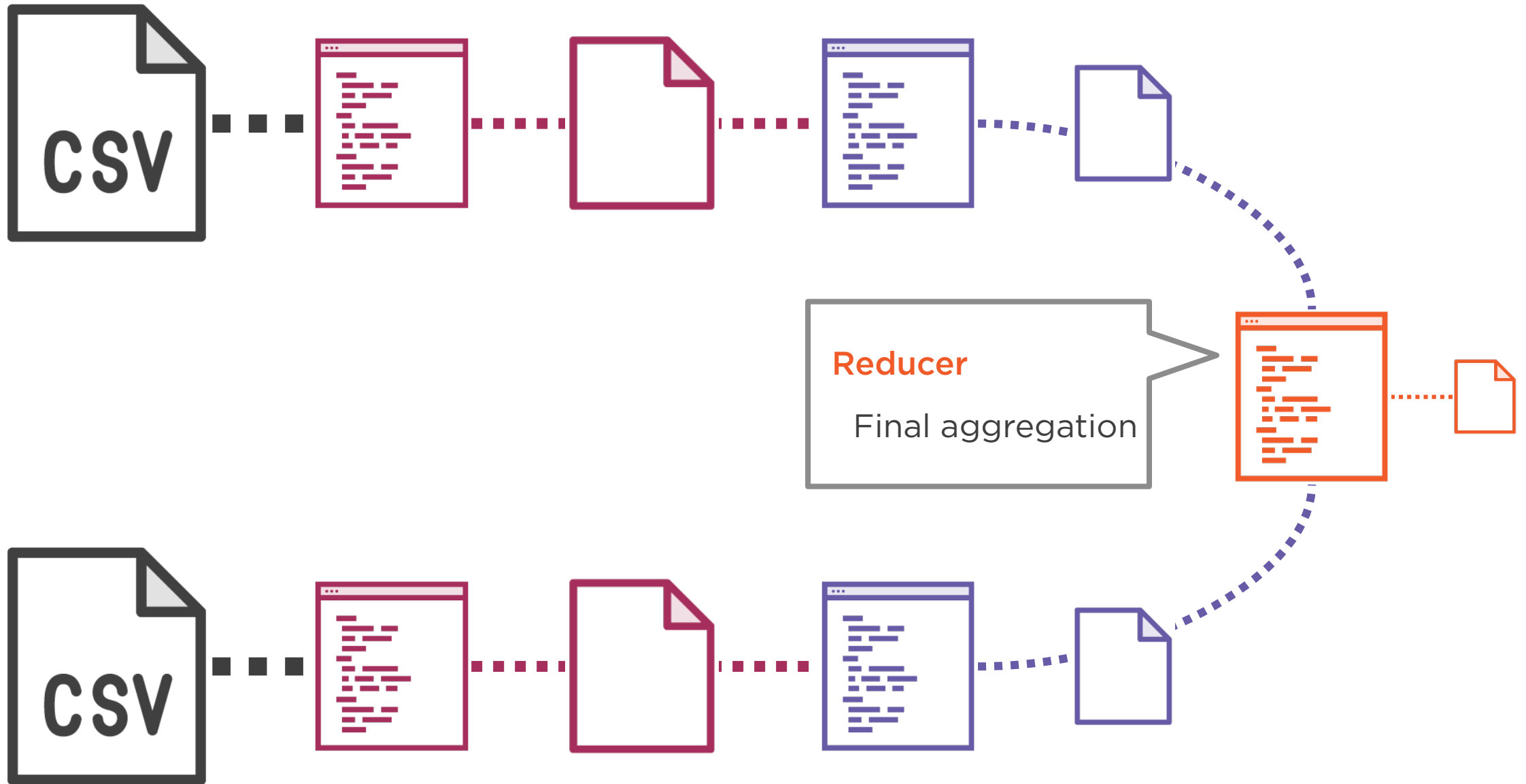
6B3,Semi-detached ageing
6B4,Older Workers...

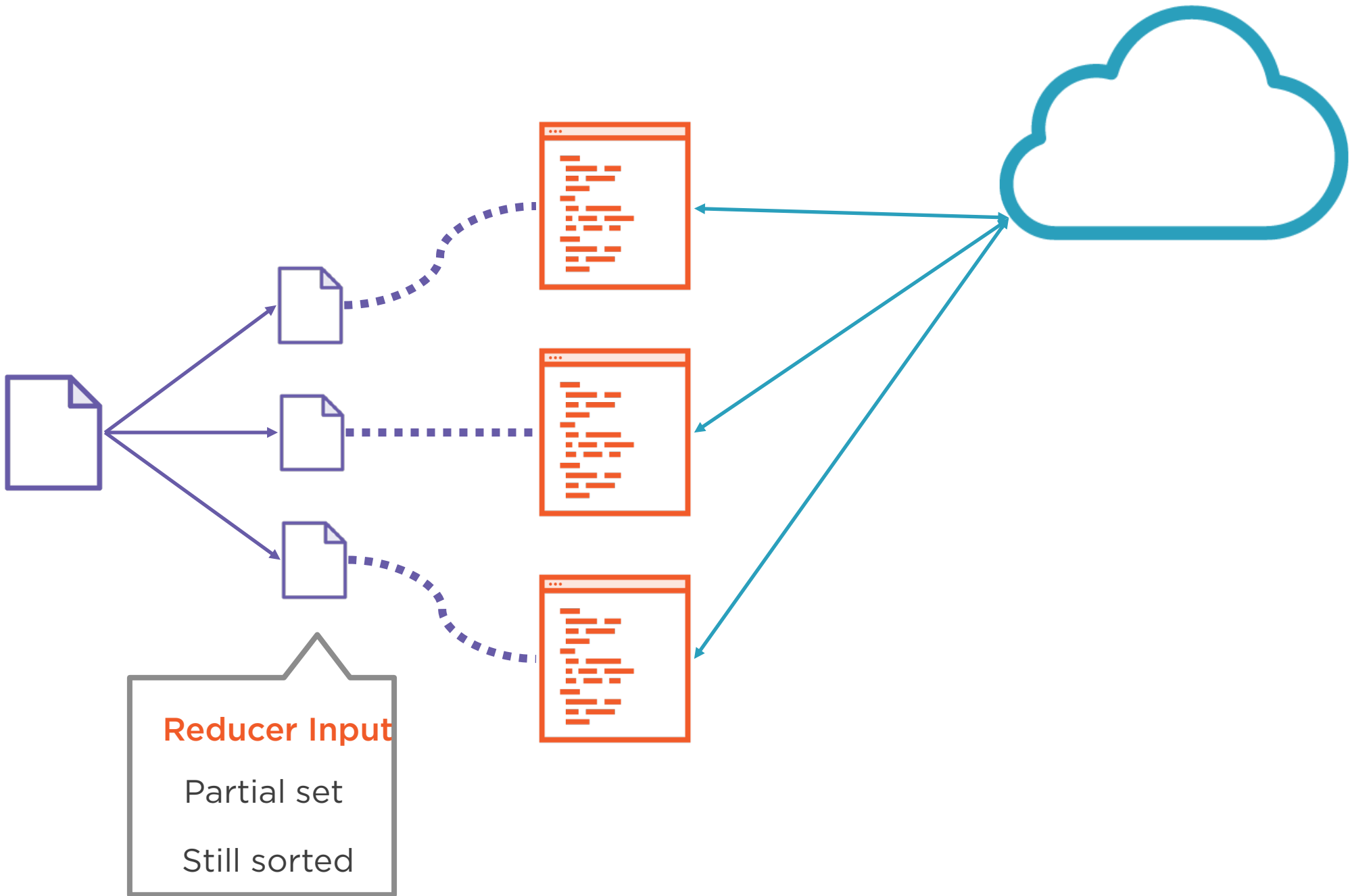


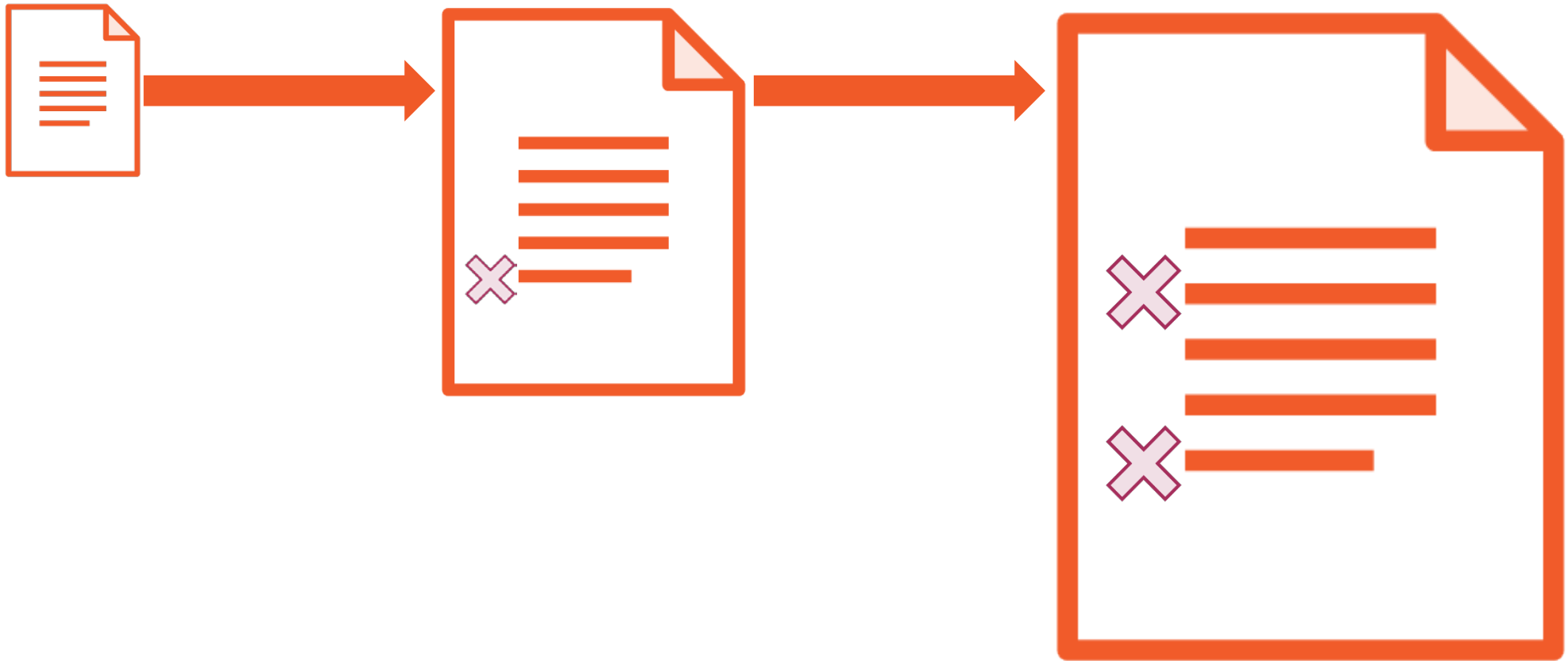
Combiner

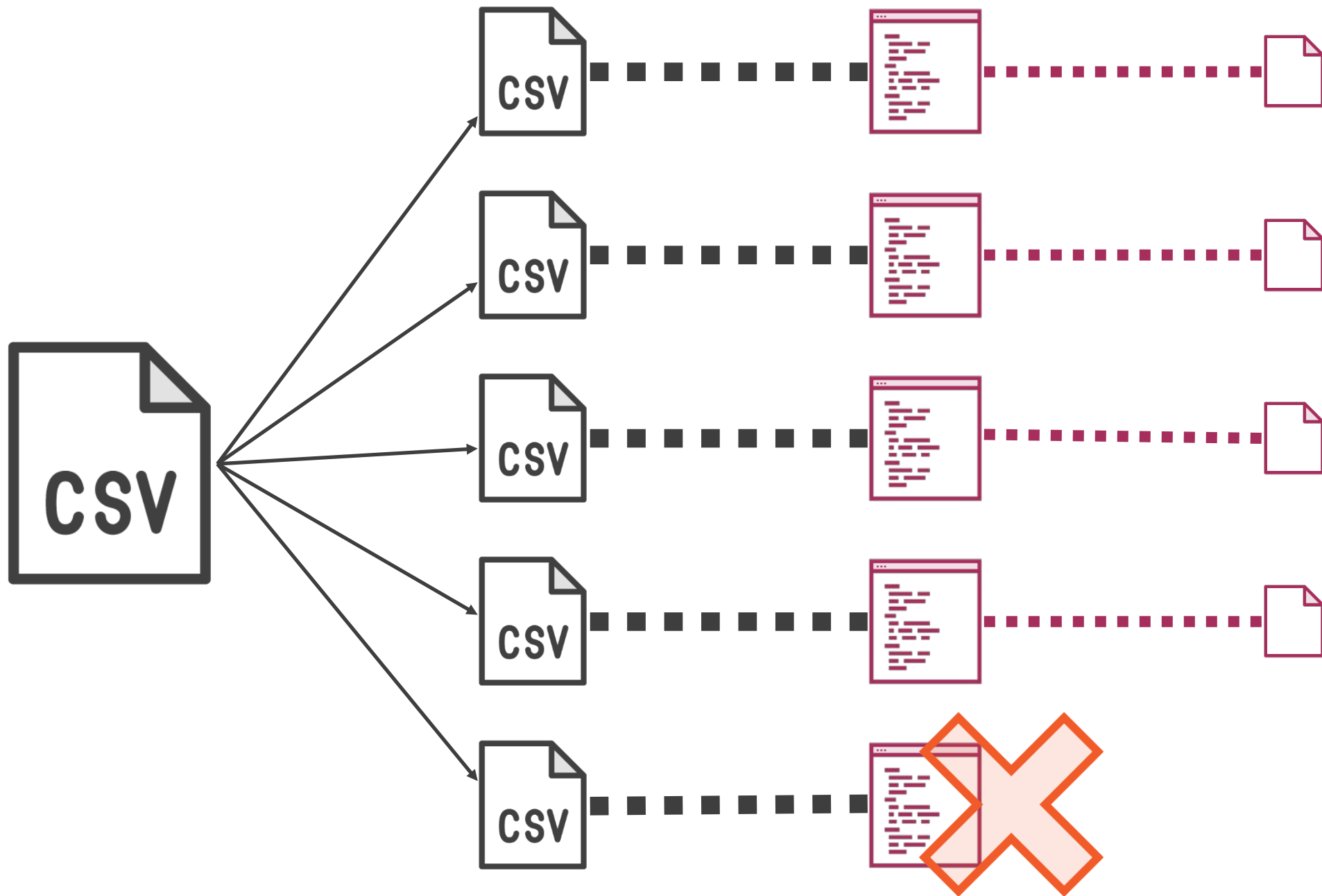
Initial aggregation











```
using (var reader = new StringReader(line))
using (var parser = new CsvParser(reader))
{
    try
    {
        //process line
    }
    catch
    {
        //ignore
    }
}
```

◀ **Dispose of disposables**

◀ **Code defensively**

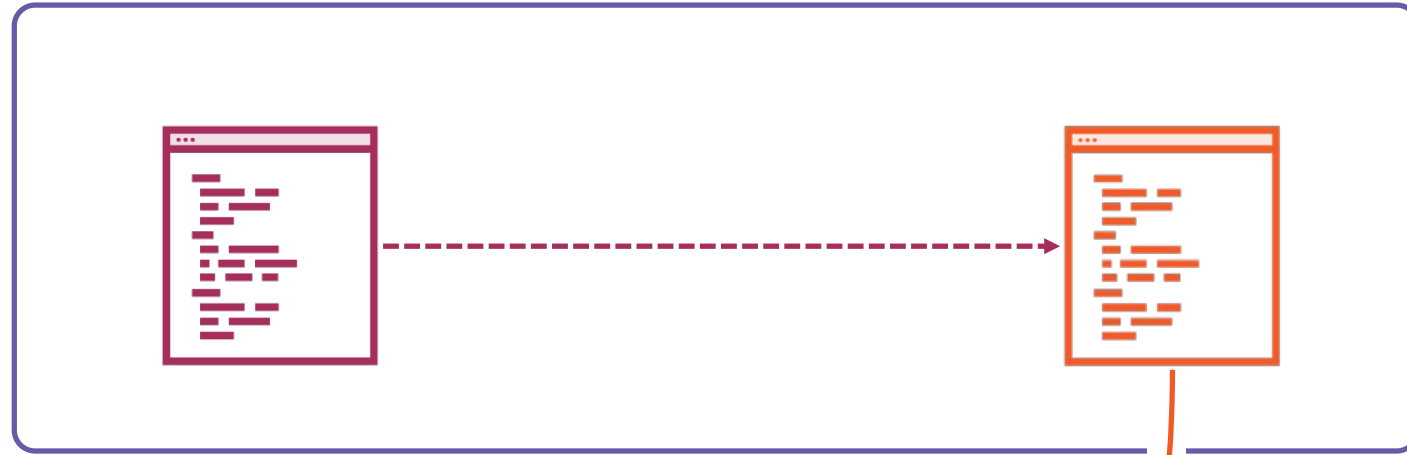
◀ **Ignore bad lines**



Job Counter

Incremented by tasks

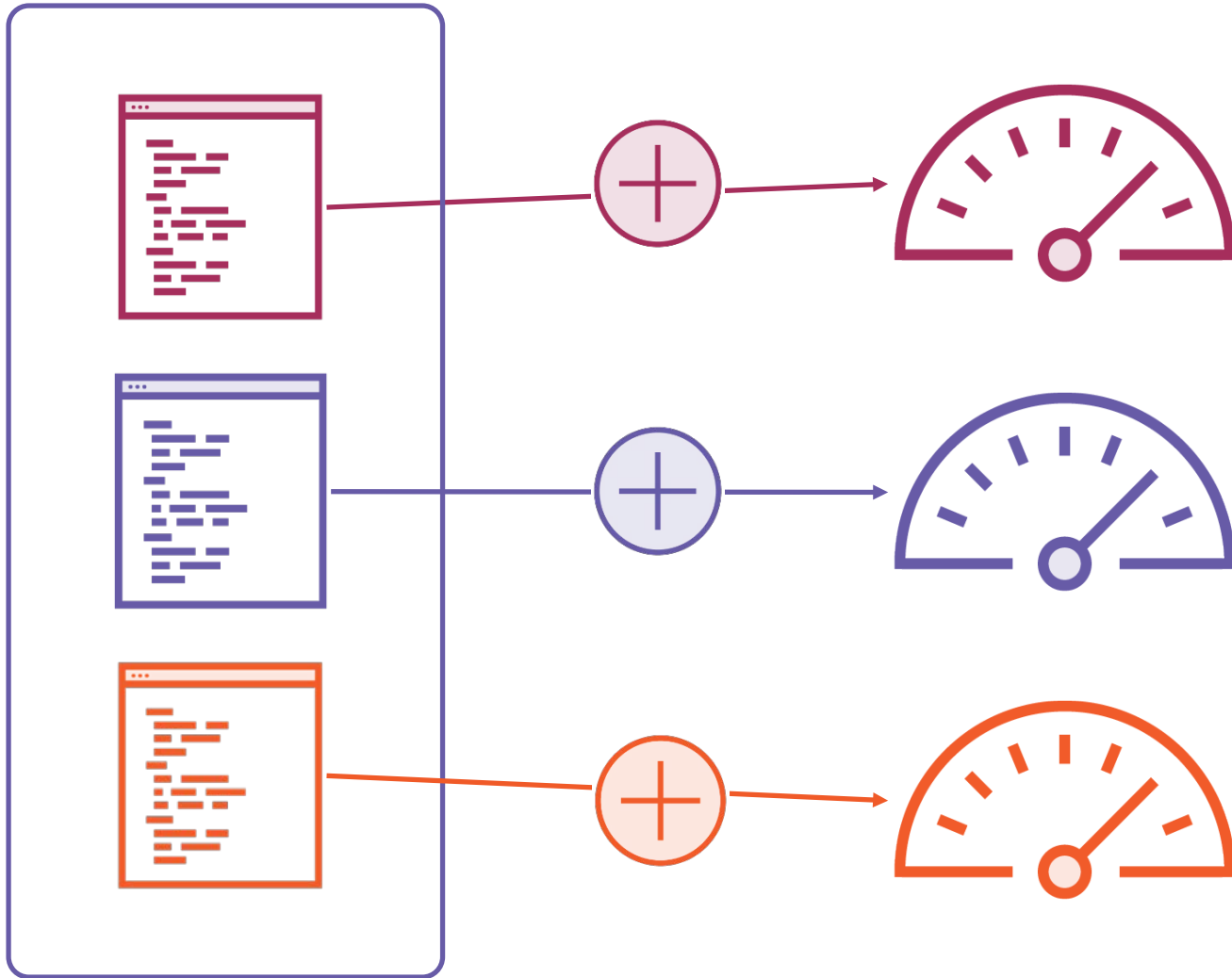
Aggregated by Hadoop



Job Counter

Incremented by tasks

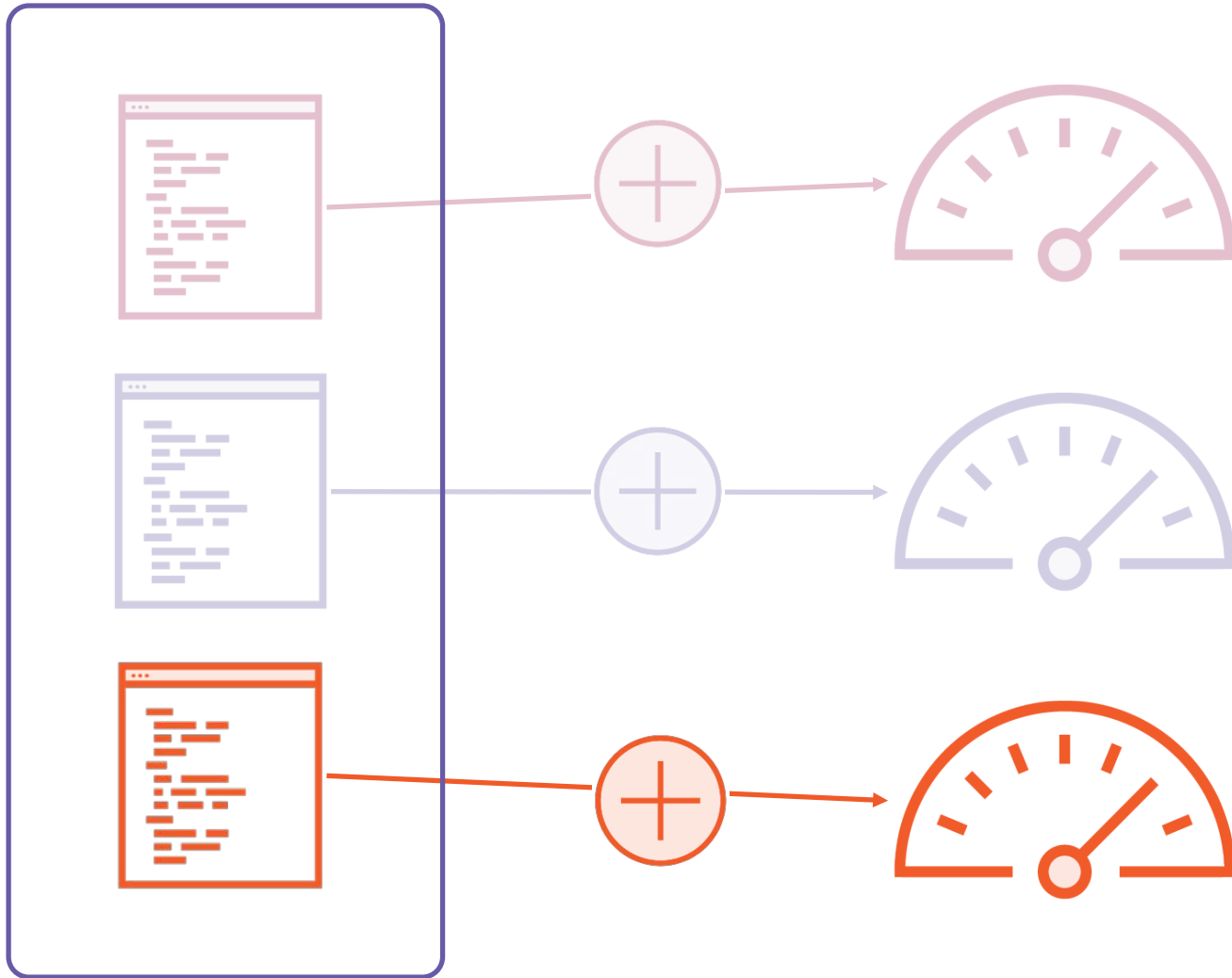
Aggregated by Hadoop



Bad input lines

Bad value format

Unknown key

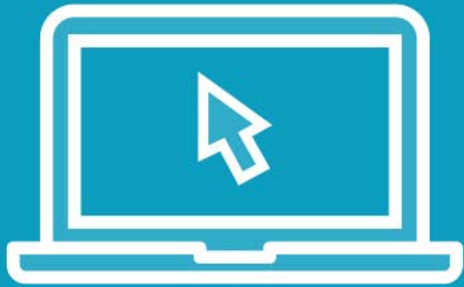


Bad input lines

Bad value format

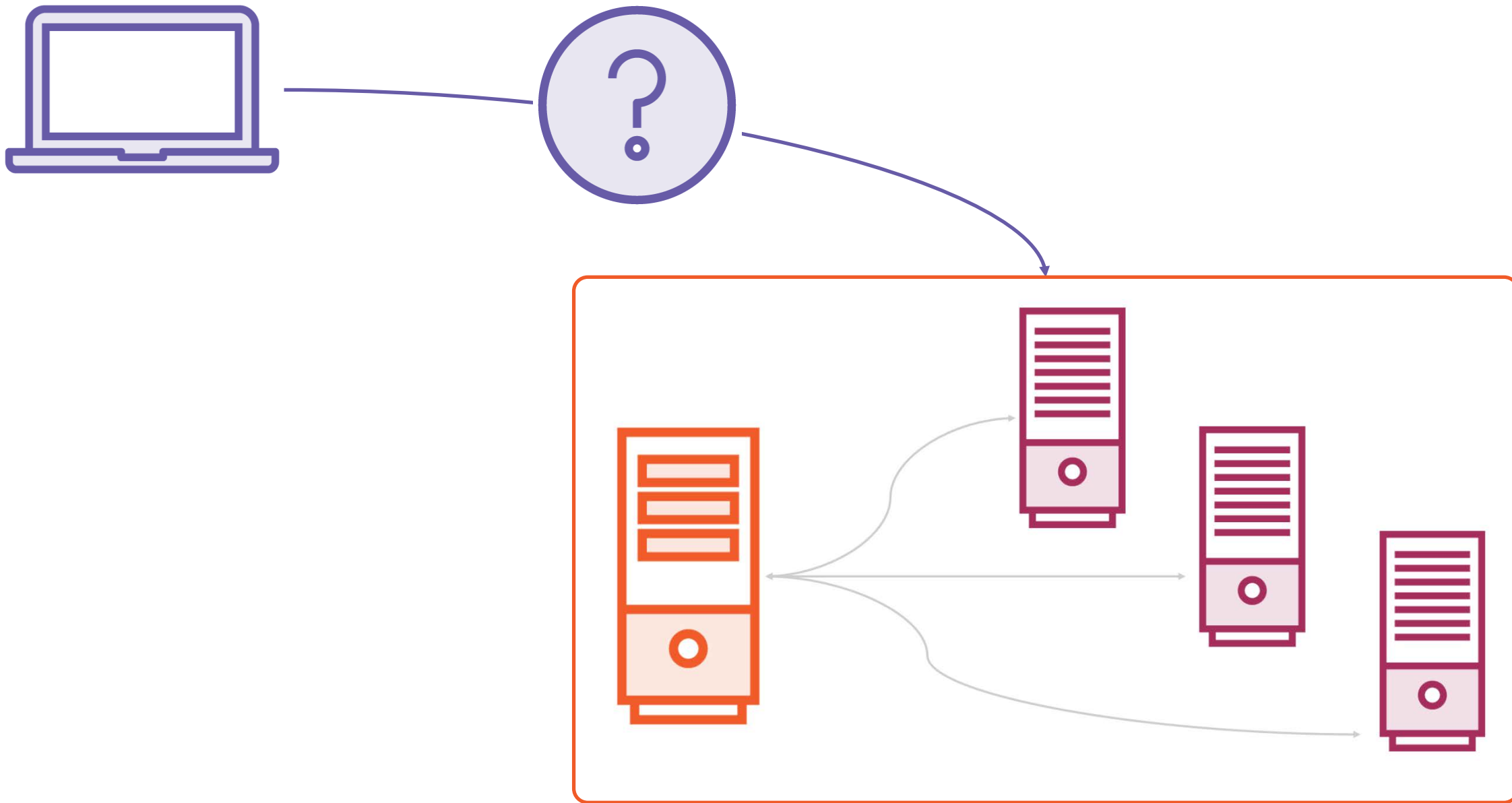
Still working...

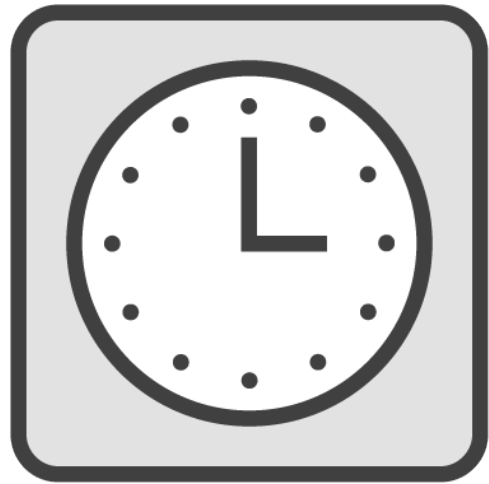
Demo

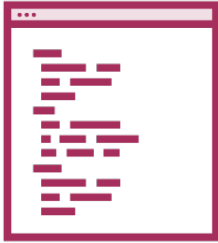


Incrementing Job Counters

- Reporting messages from .NET
- Writing error logs
- Assessing job performance

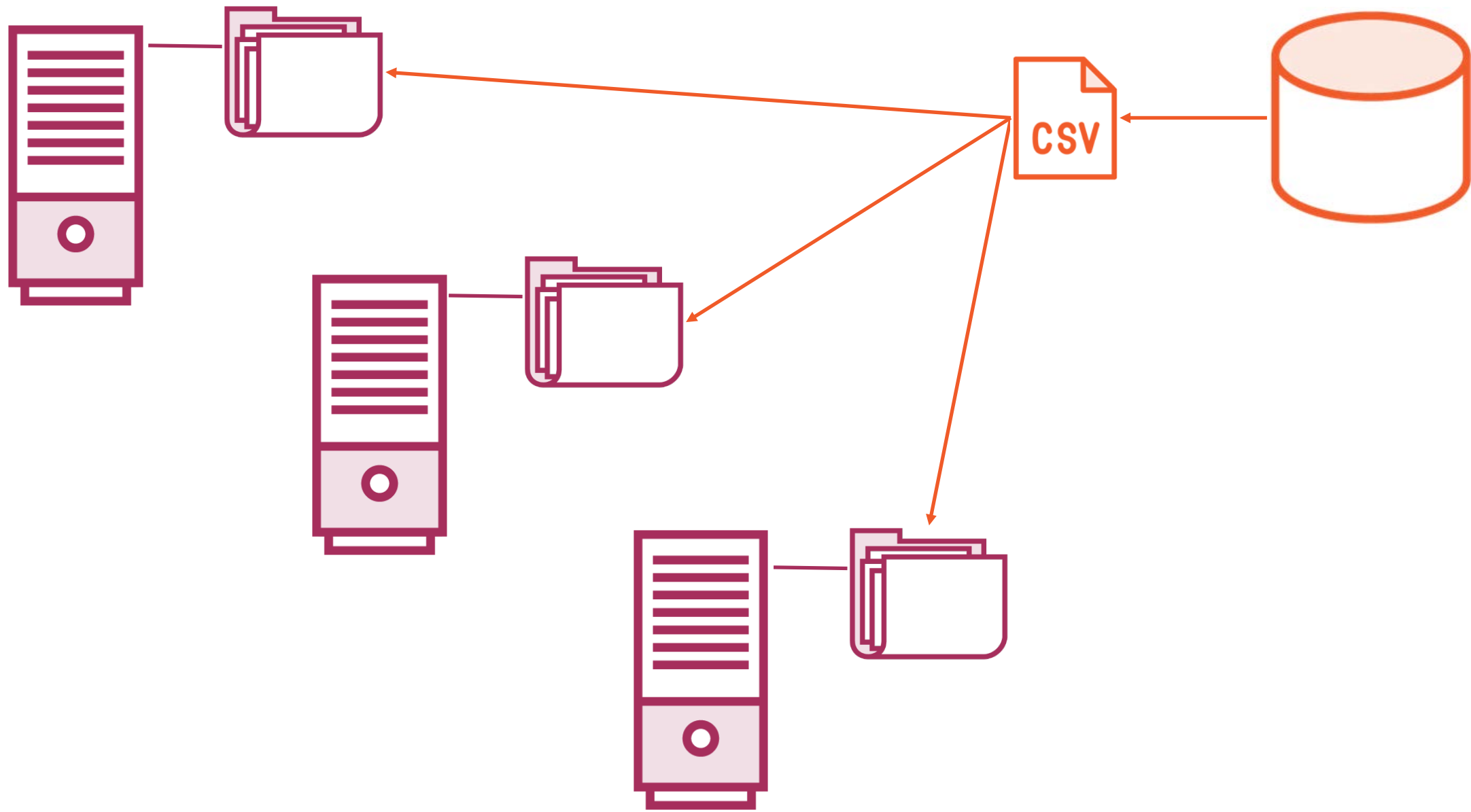


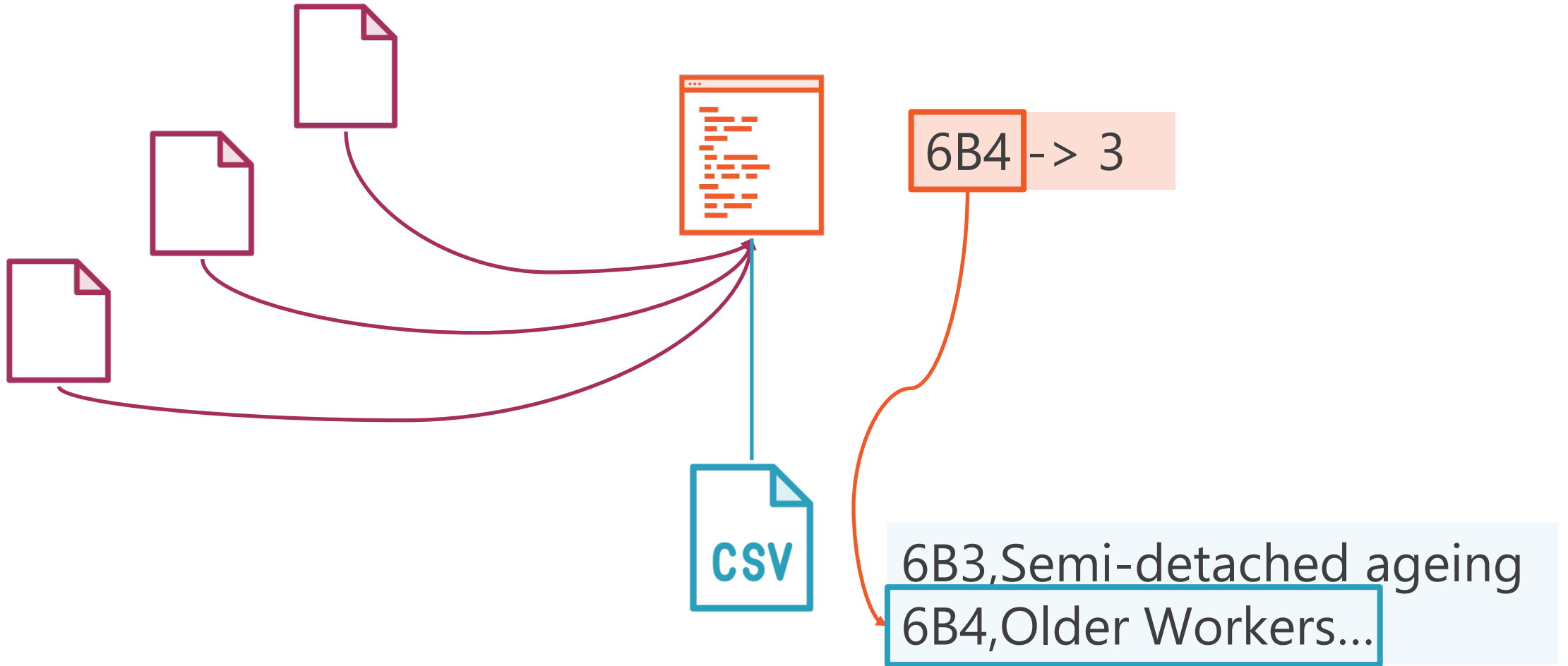


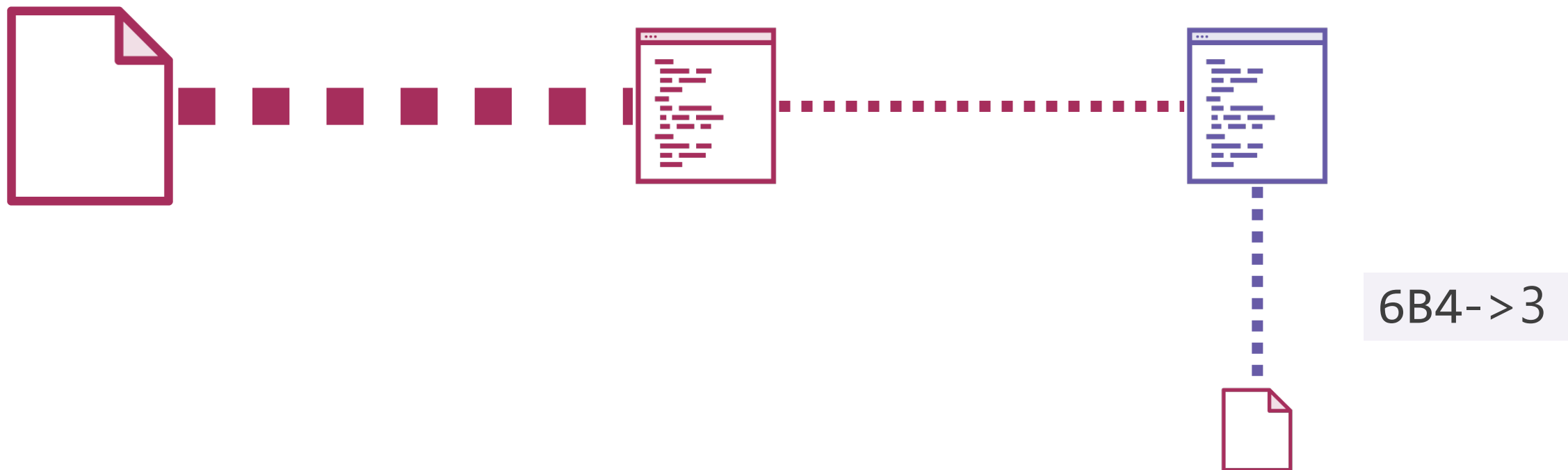


ENHANCED MAPREDUCE

- Using the distributed cache
- Adding a combiner
- Running multiple reducers
- Reporting counters



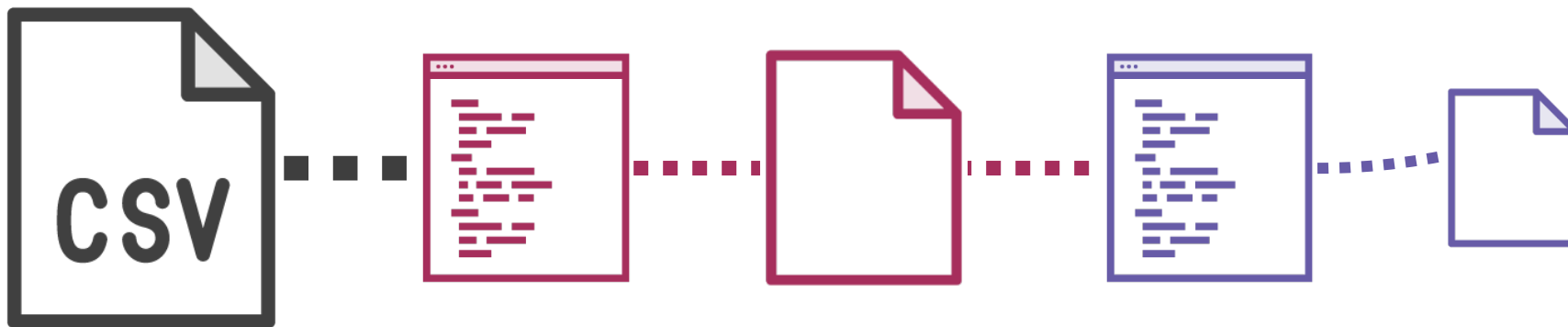


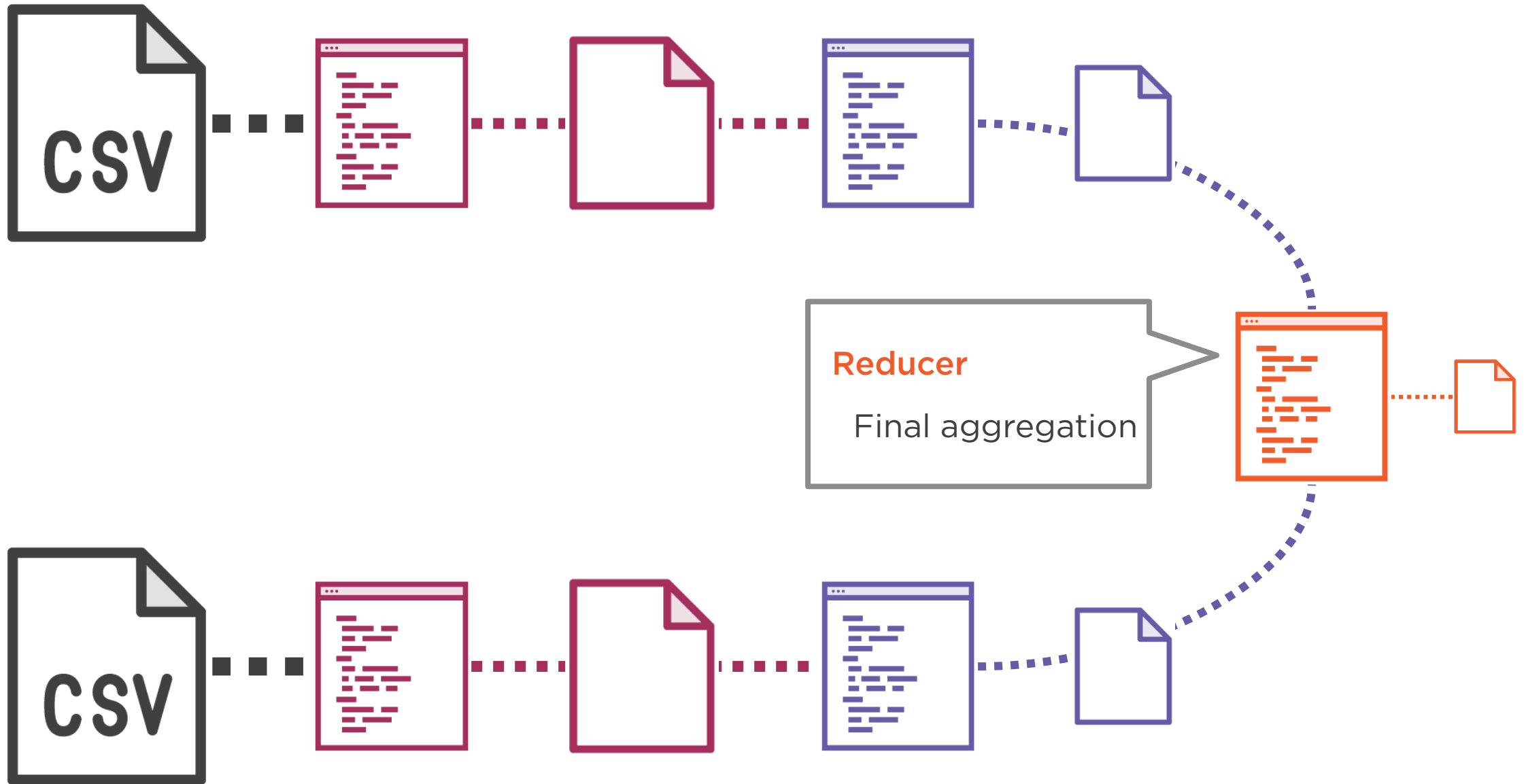


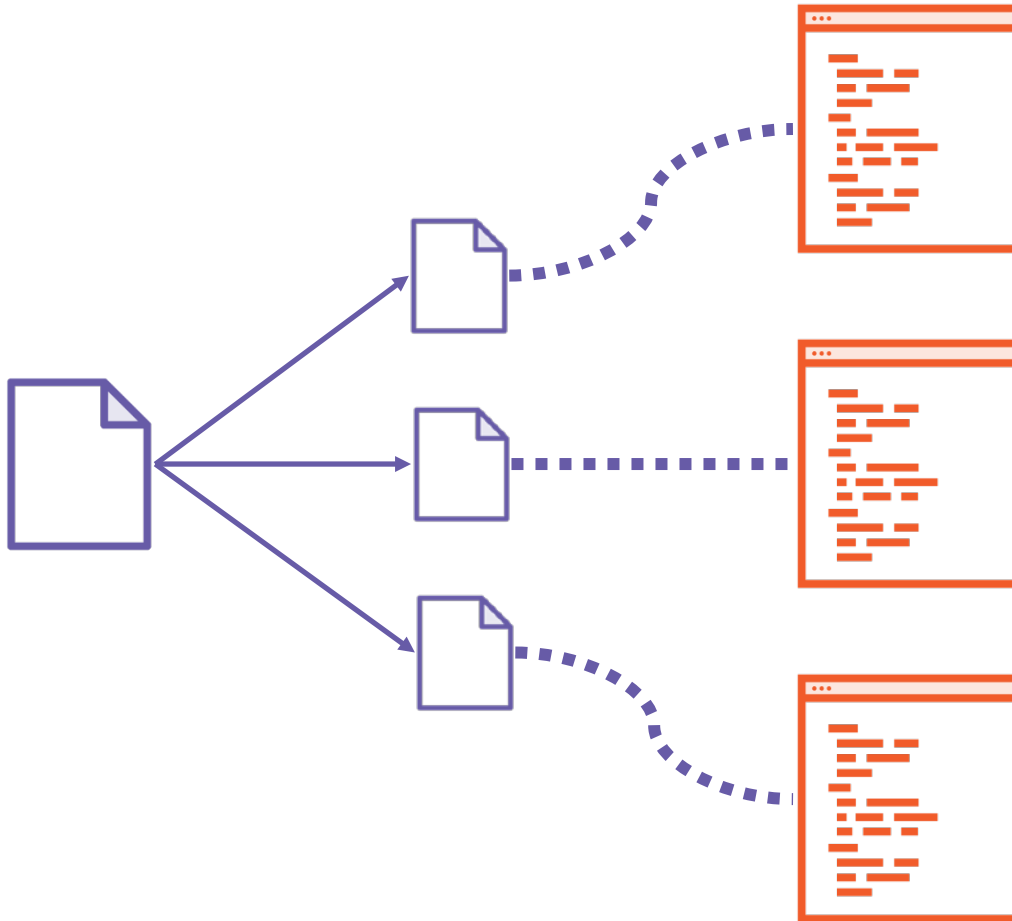


Combiner

Initial aggregation



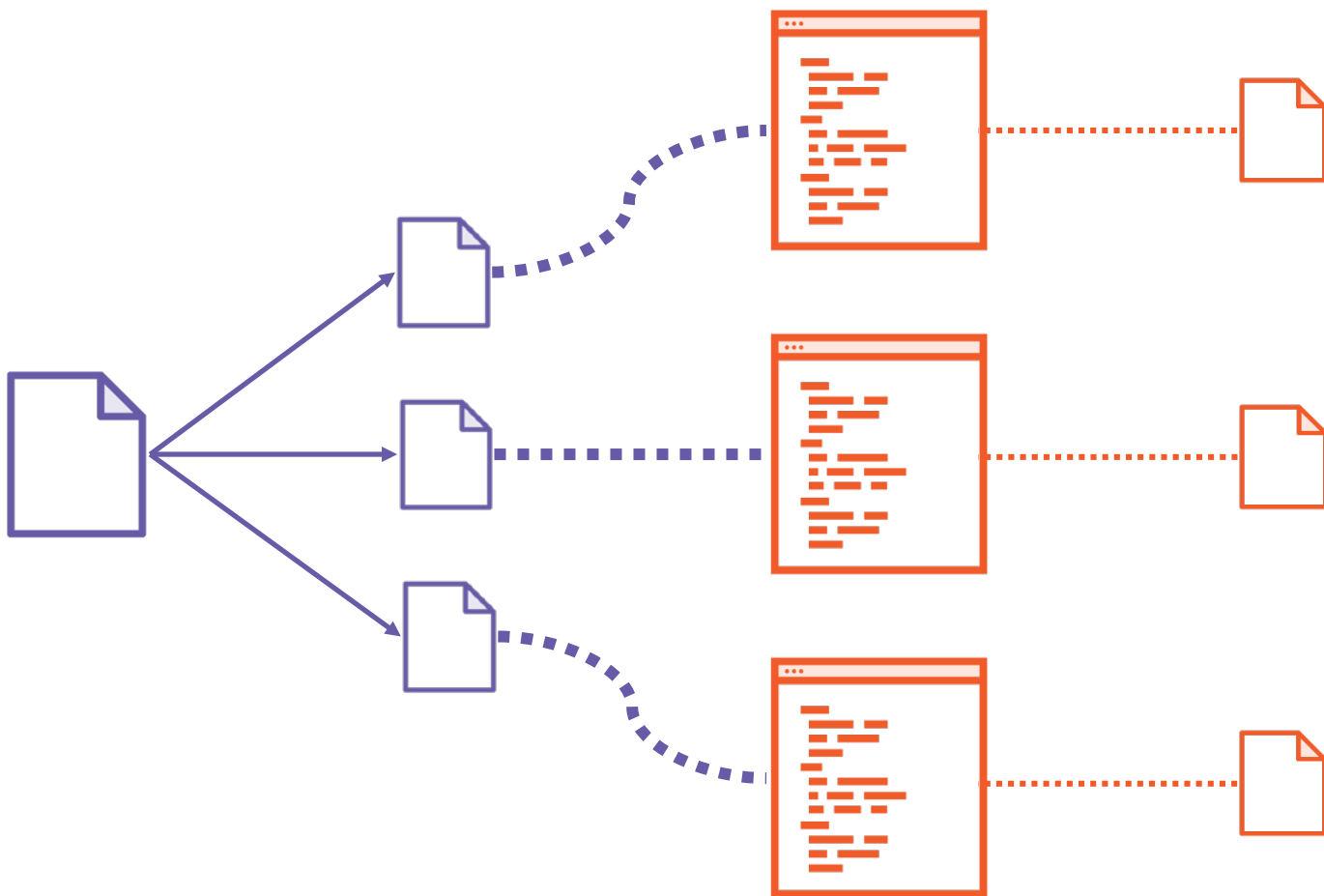


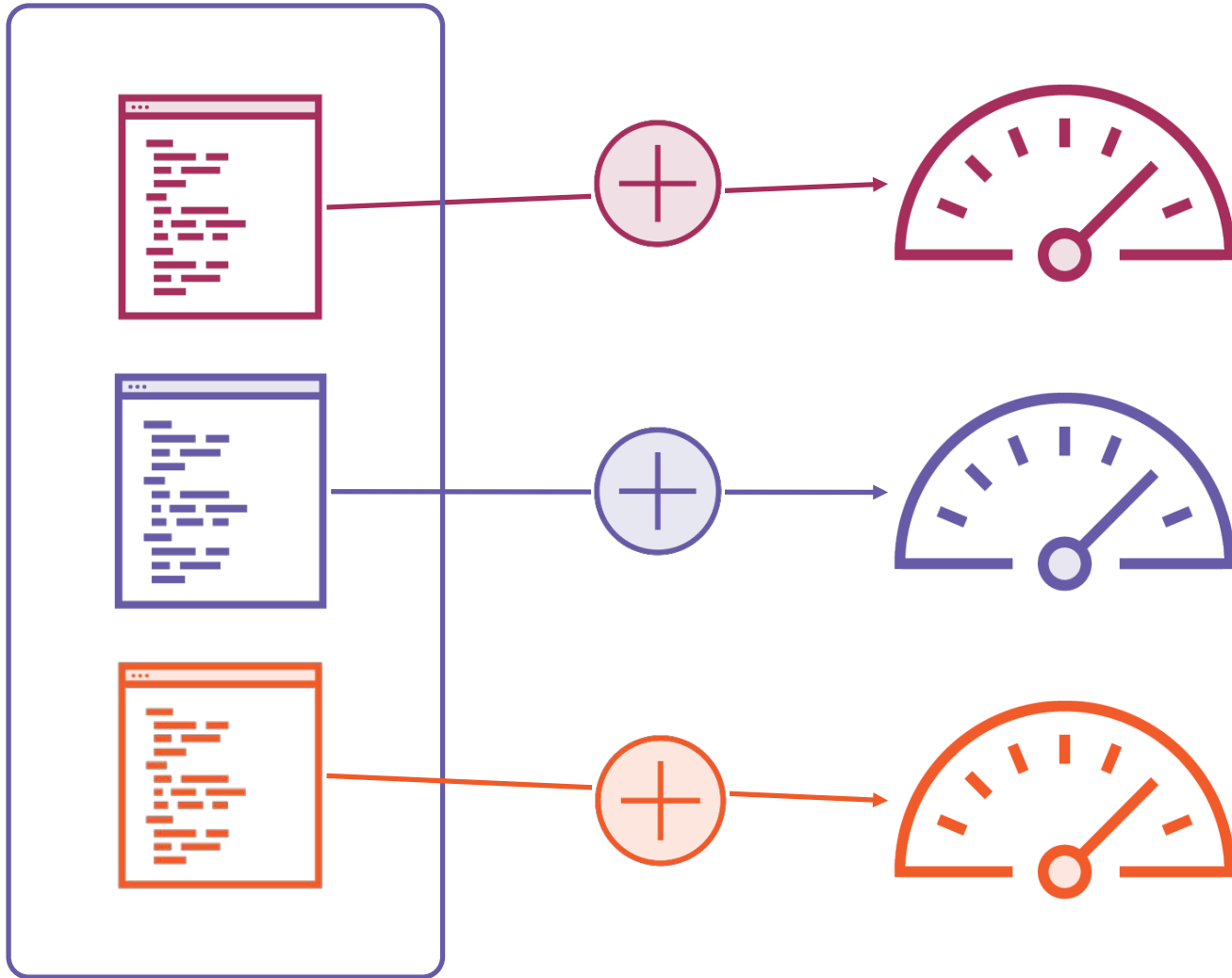


Multiple Reducers

Job configuration

Run in parallel

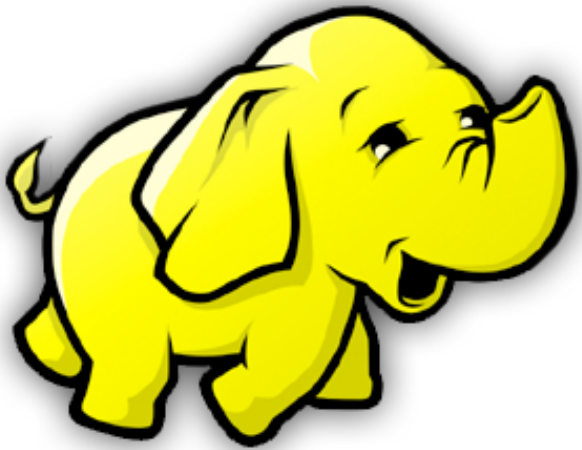




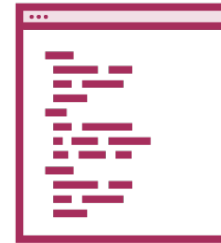
Bad input lines

Bad value format

Unknown key



```
> hadoop jar streaming-x.y.z.jar
```





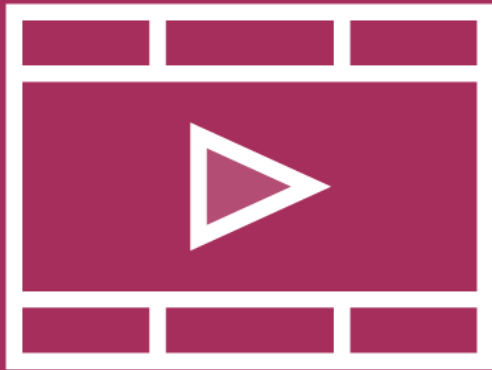
Apache Ranger



Apache Ambari



Coming Next



Navigating the Hadoop Ecosystem

- Hive: SQL query language
- HBase: real-time data access
- Spark: in-memory analysis