Processing Data with MapReduce

Overview

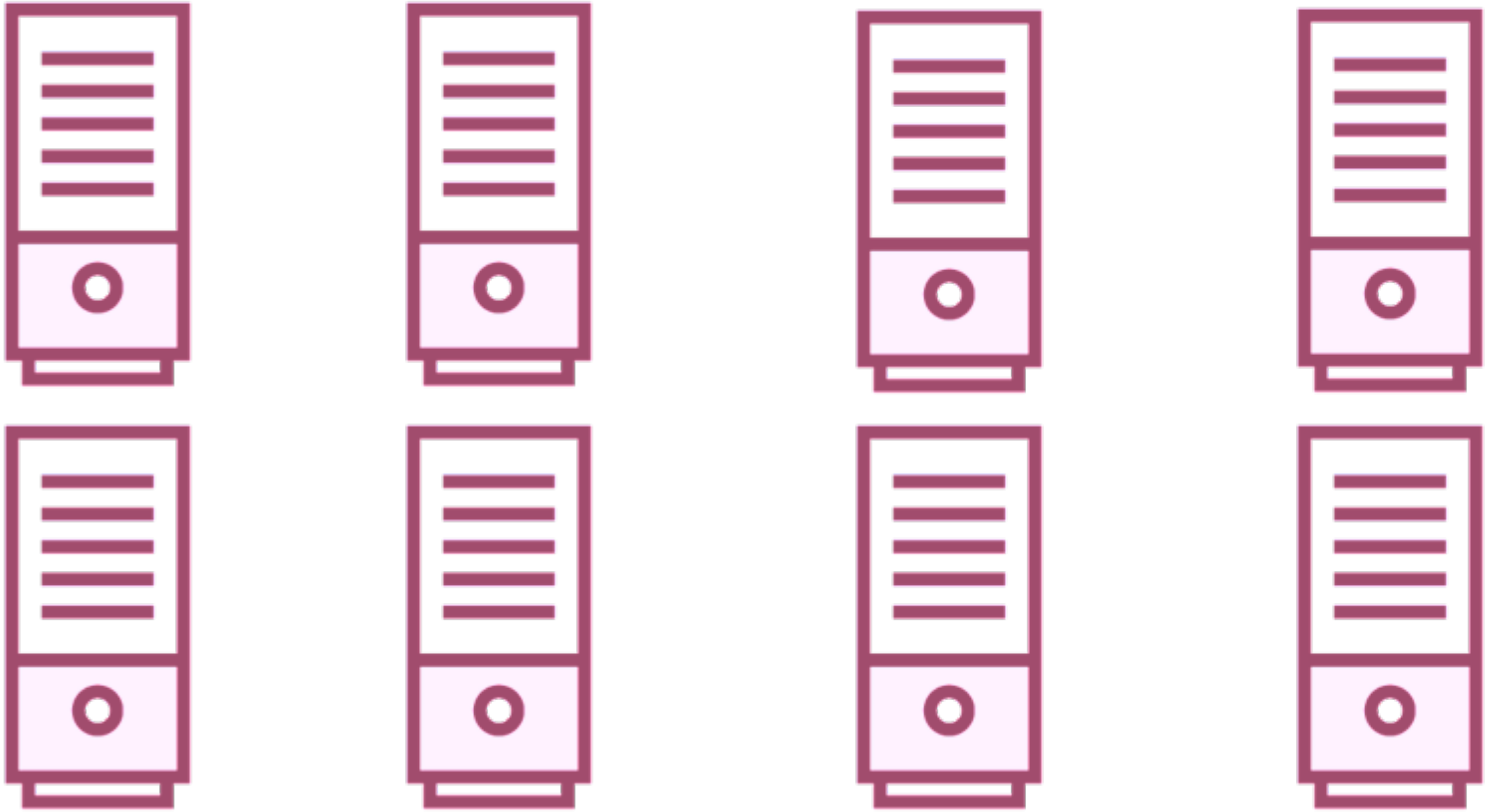
Setting up a MapReduce job for a simple counting task

Submitting a MapReduce job to Hadoop and monitoring it

MapReduce

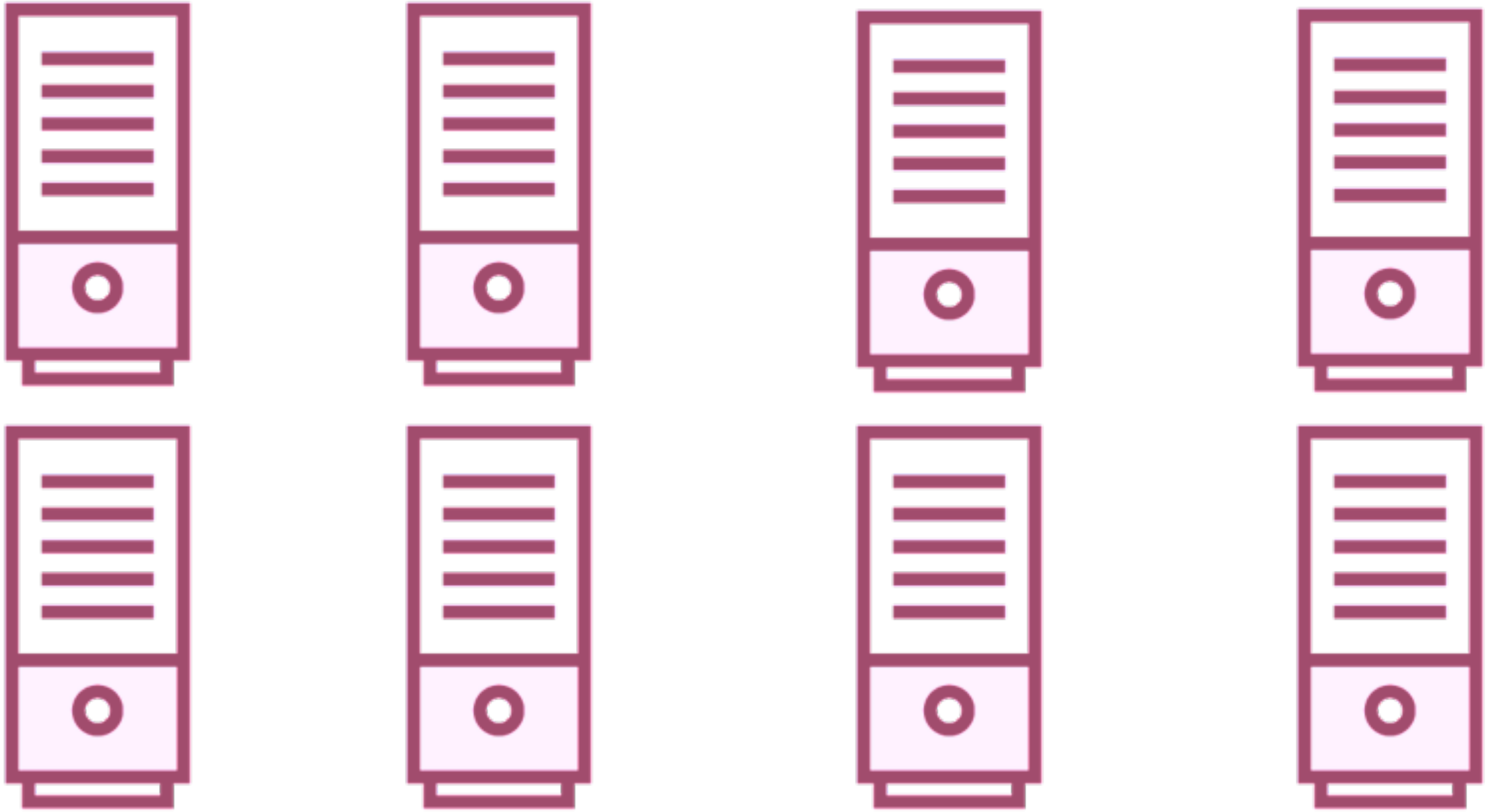
Processing huge amounts of data

MapReduce



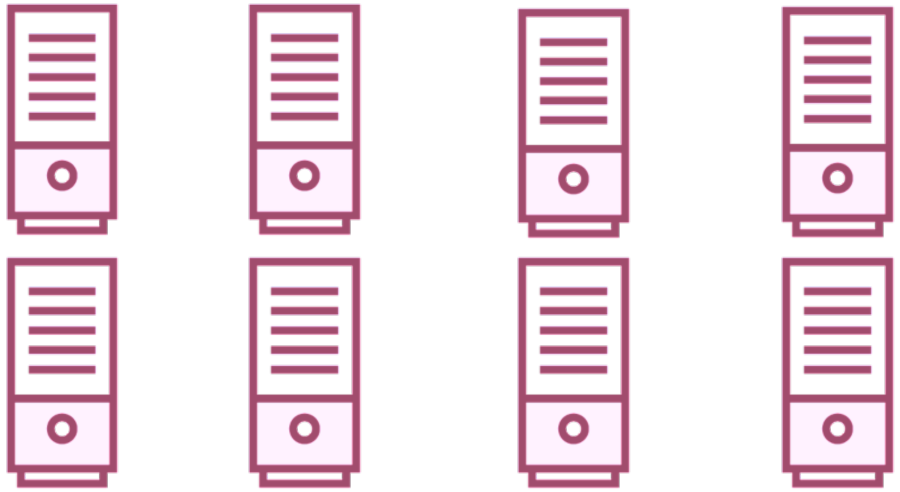
Requires running processes on many machines

MapReduce



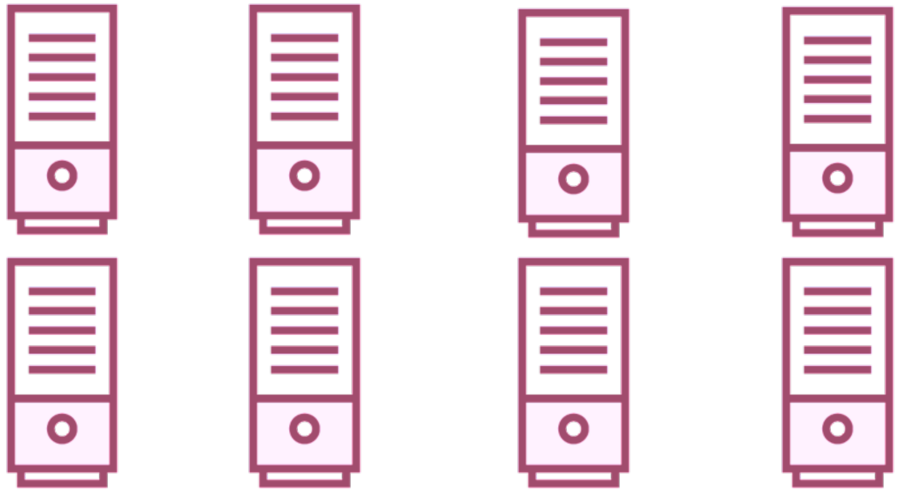
A distributed system

MapReduce



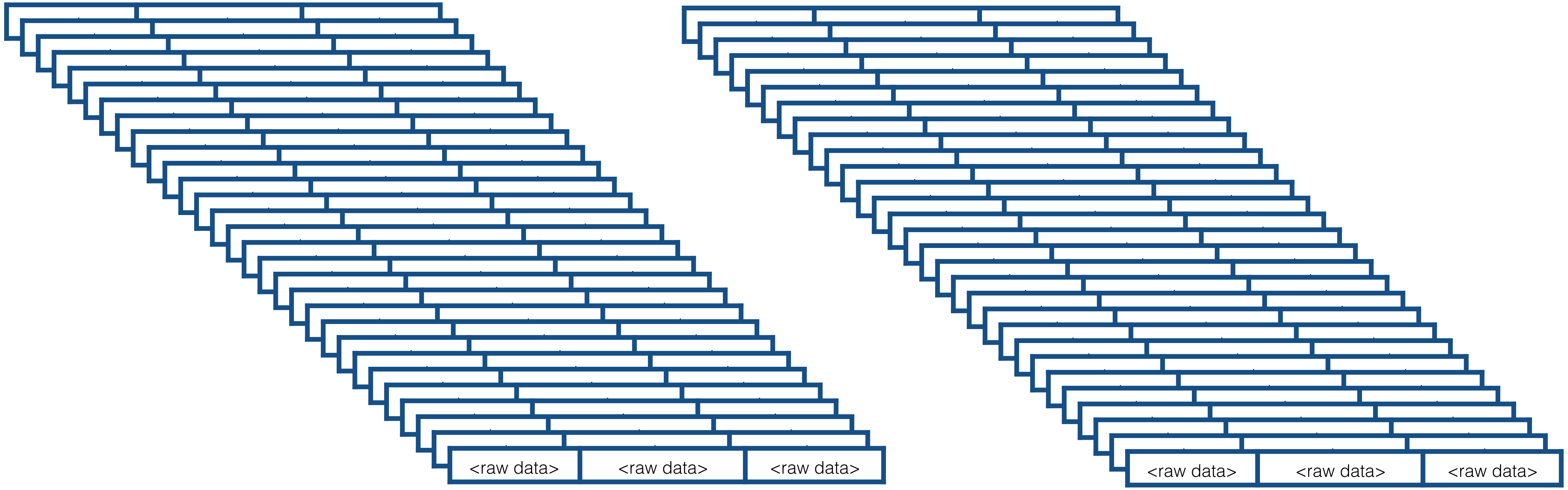
MapReduce is a programming paradigm

MapReduce



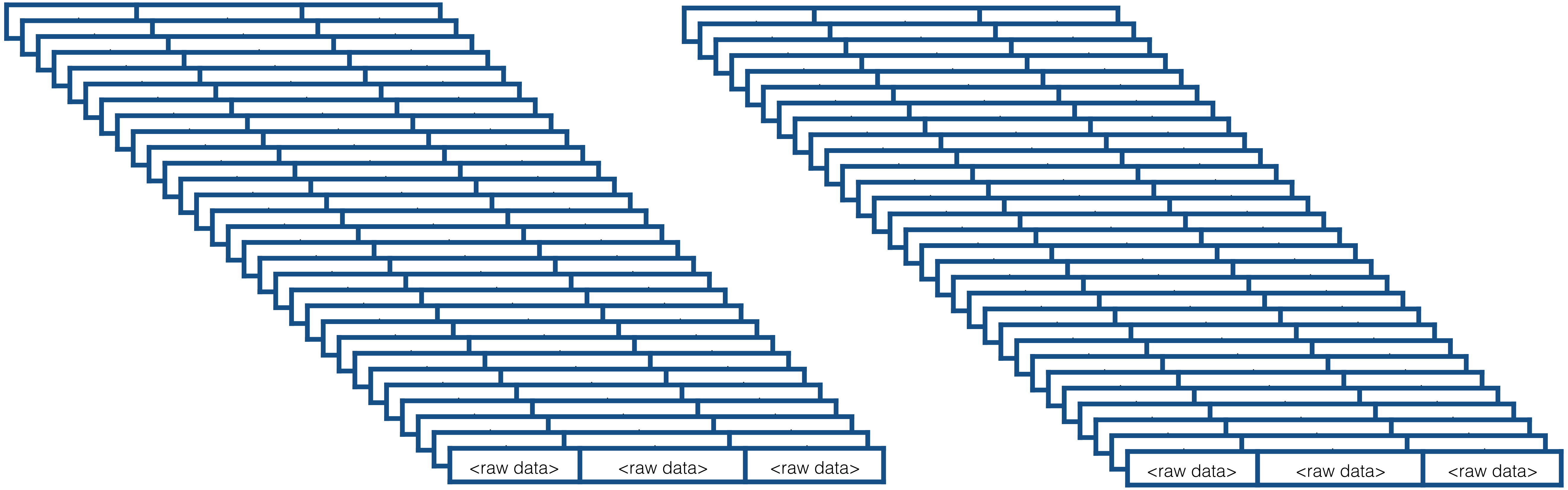
Takes advantage of the inherent parallelism in data processing

MapReduce



Modern systems generate millions of records of raw data

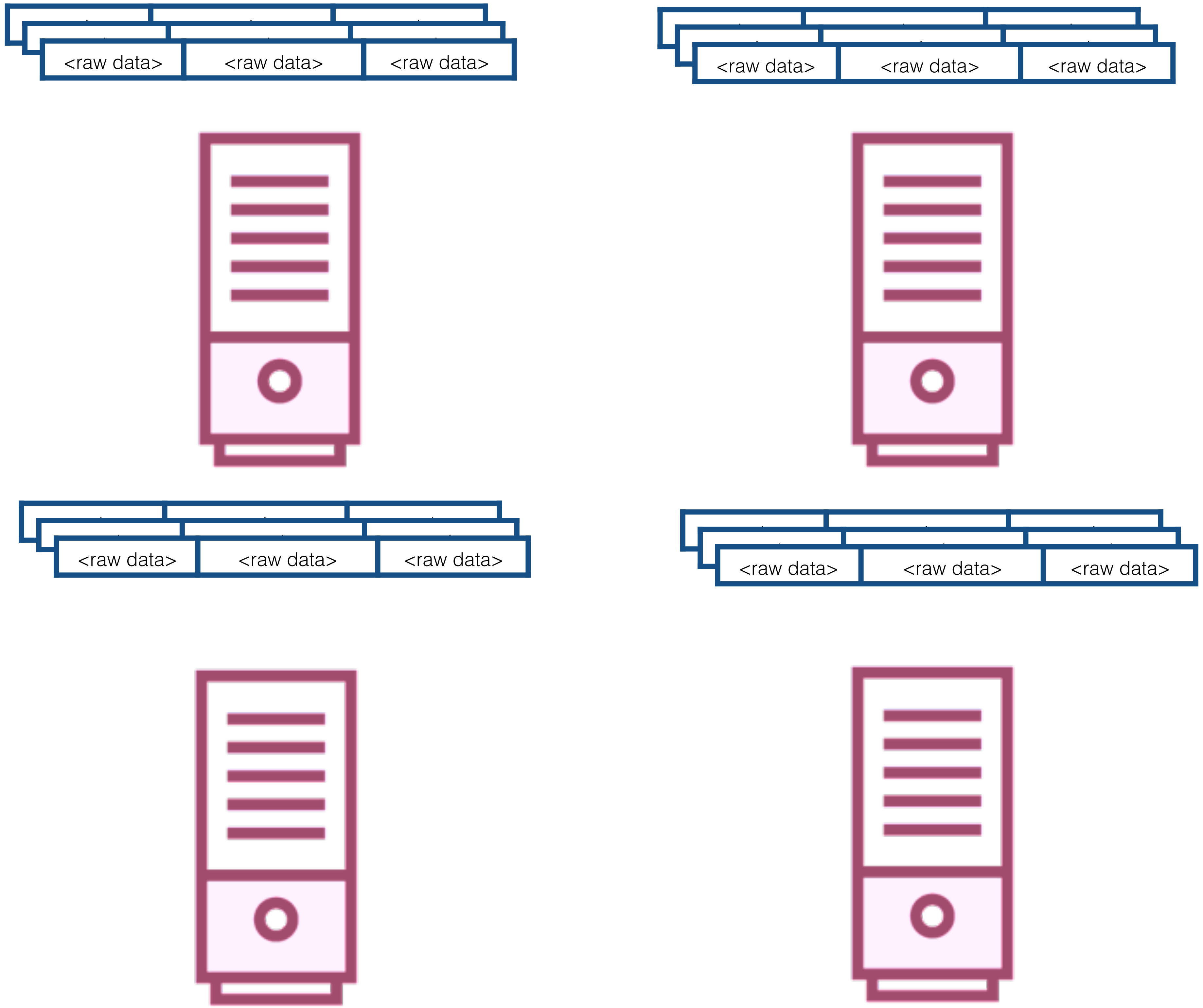
MapReduce



A task of this scale is processed in two stages

map reduce

map



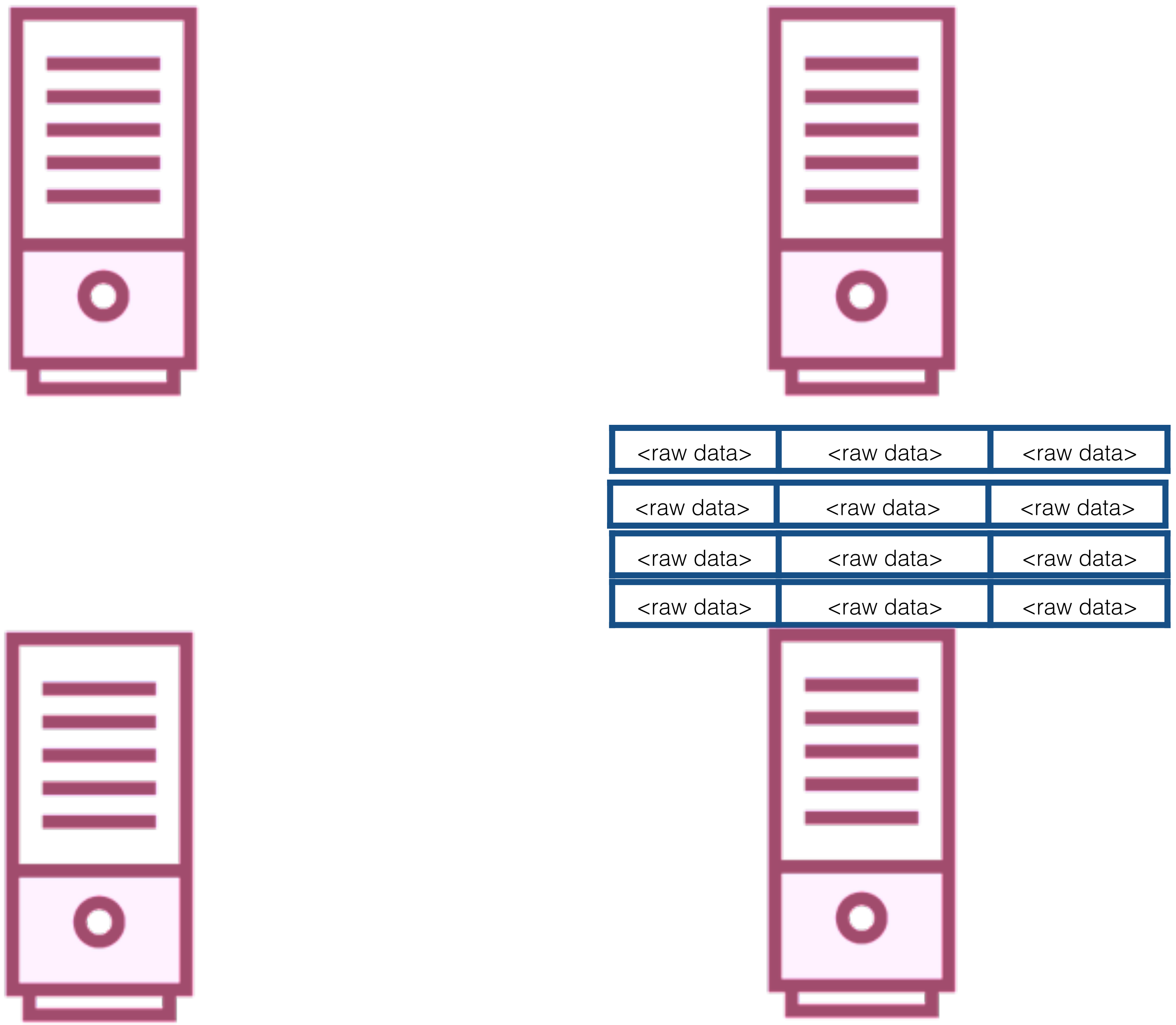
<raw data> <raw data> <raw data>

<raw data> <raw data> <raw data>

<raw data> <raw data> <raw data>

<raw data> <raw data> <raw data>

reduce



<raw data>	<raw data>	<raw data>
<raw data>	<raw data>	<raw data>
<raw data>	<raw data>	<raw data>
<raw data>	<raw data>	<raw data>

MapReduce

`map` `reduce`

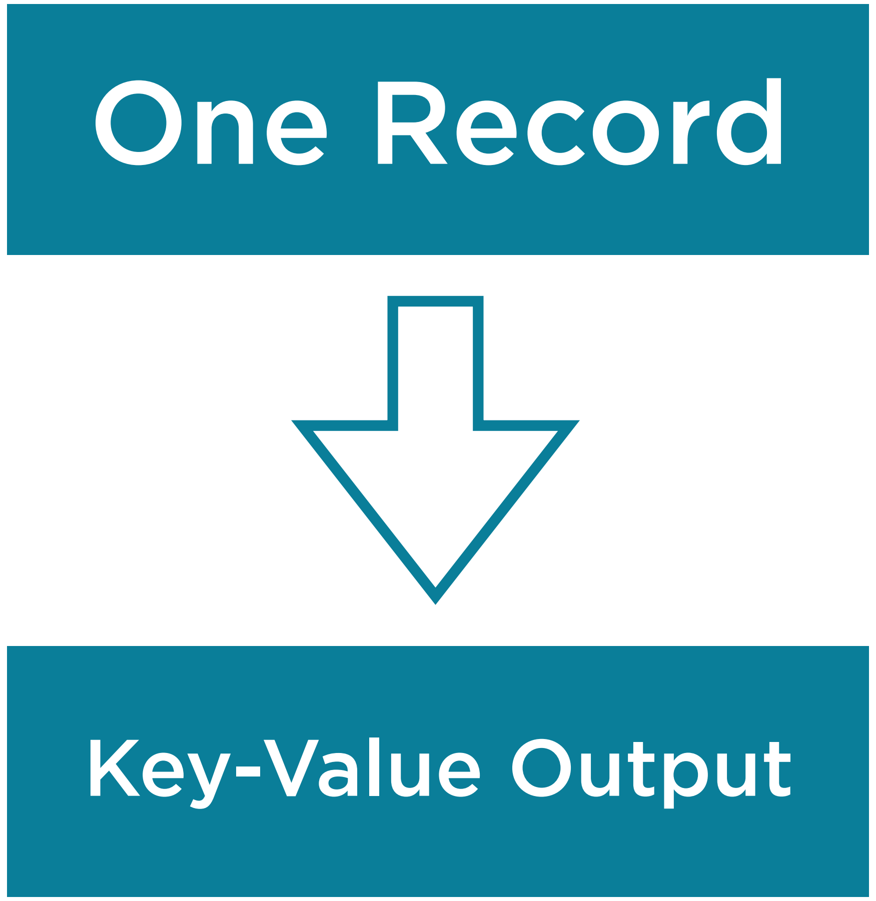
The programmer defines these 2 functions

Hadoop does the rest - behind the scenes

map

An operation performed in parallel, on small portions of the dataset

map



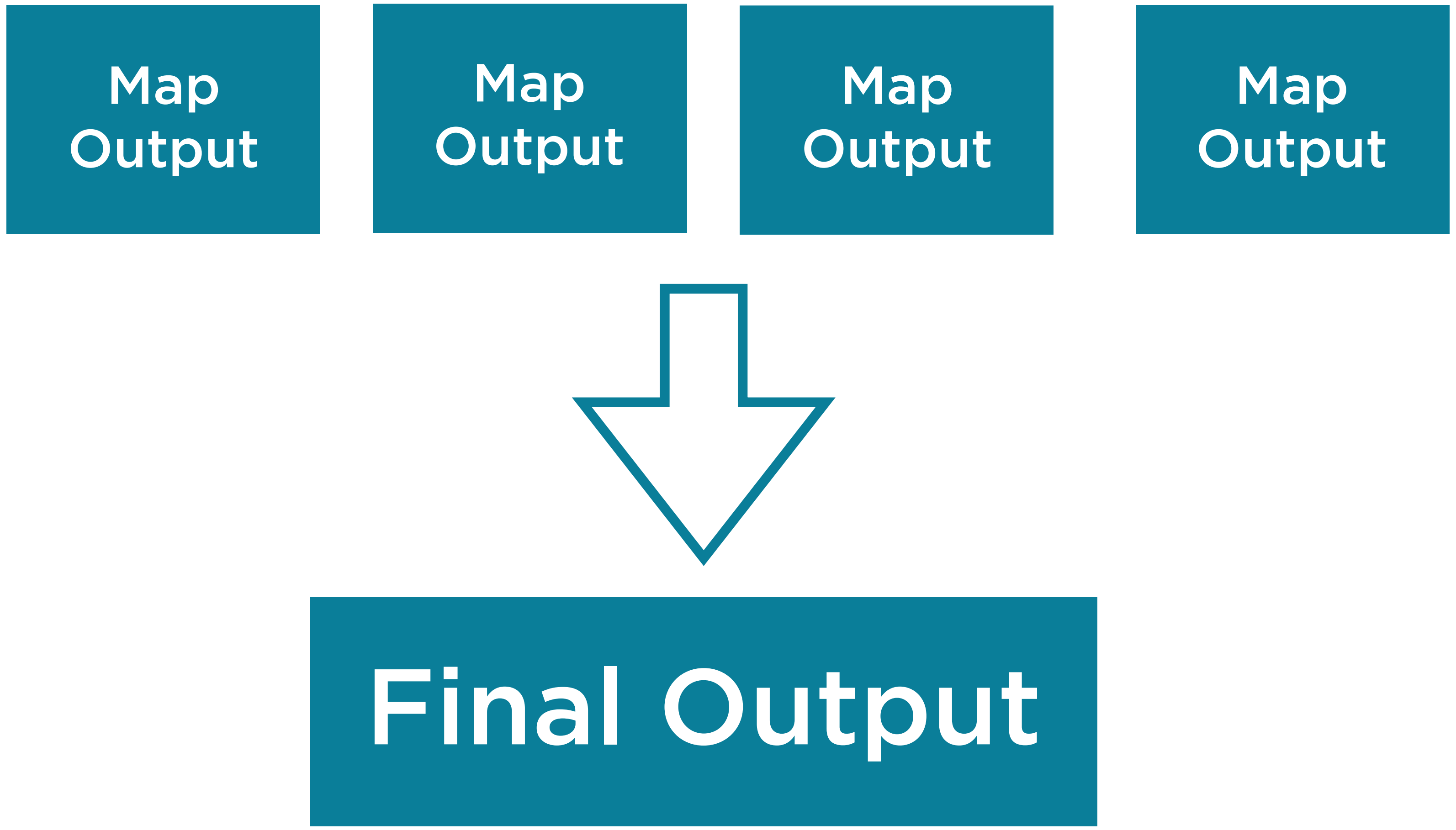
One Record

Key-Value Output

reduce

An operation to combine the results of the map step

reduce



Map Output

Map Output

Map Output

Map Output

Final Output

map A step that can be performed in parallel

reduce A step to combine the intermediate results

Counting Word Frequencies

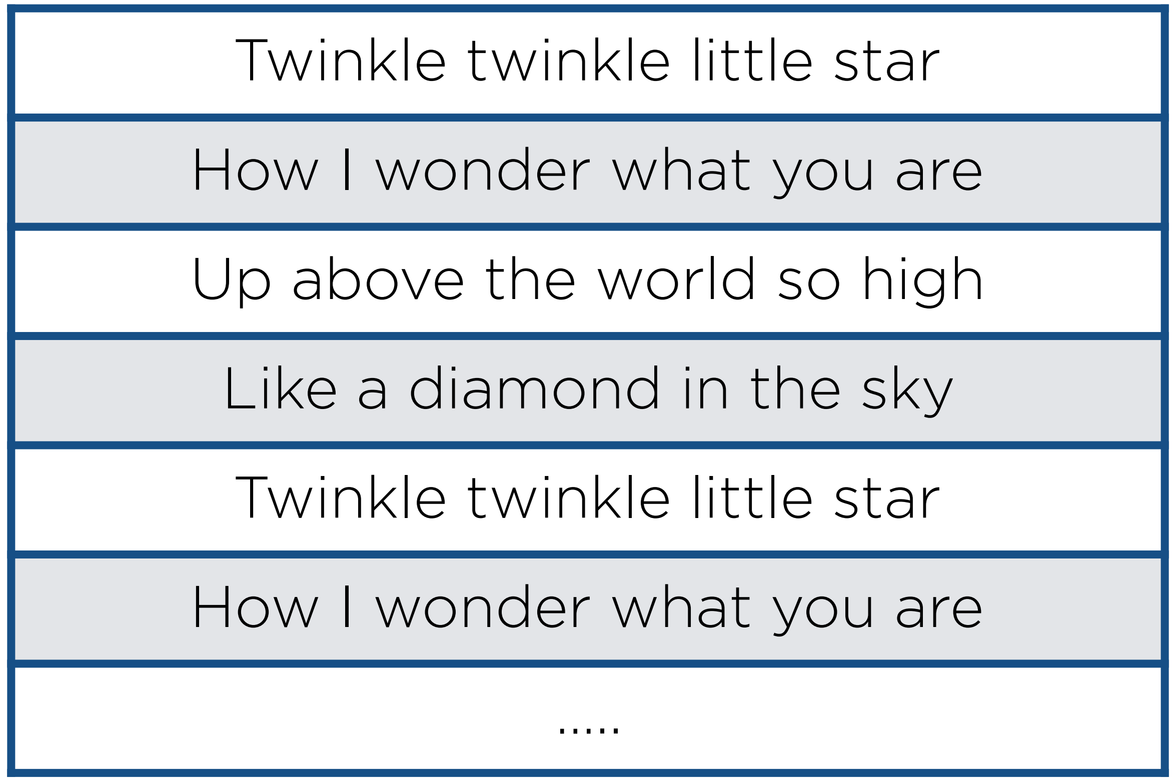
Consider a large text file

Twinkle twinkle little star
How I wonder what you are
Up above the world so high
Like a diamond in the sky
Twinkle twinkle little star
How I wonder what you are
.....

How?

Word	Frequency
above	14
are	20
how	21
star	22
twinkle	32
...	..

MapReduce Flow



Twinkle twinkle little star

How I wonder what you are

Up above the world so high

Like a diamond in the sky

Twinkle twinkle little star

How I wonder what you are

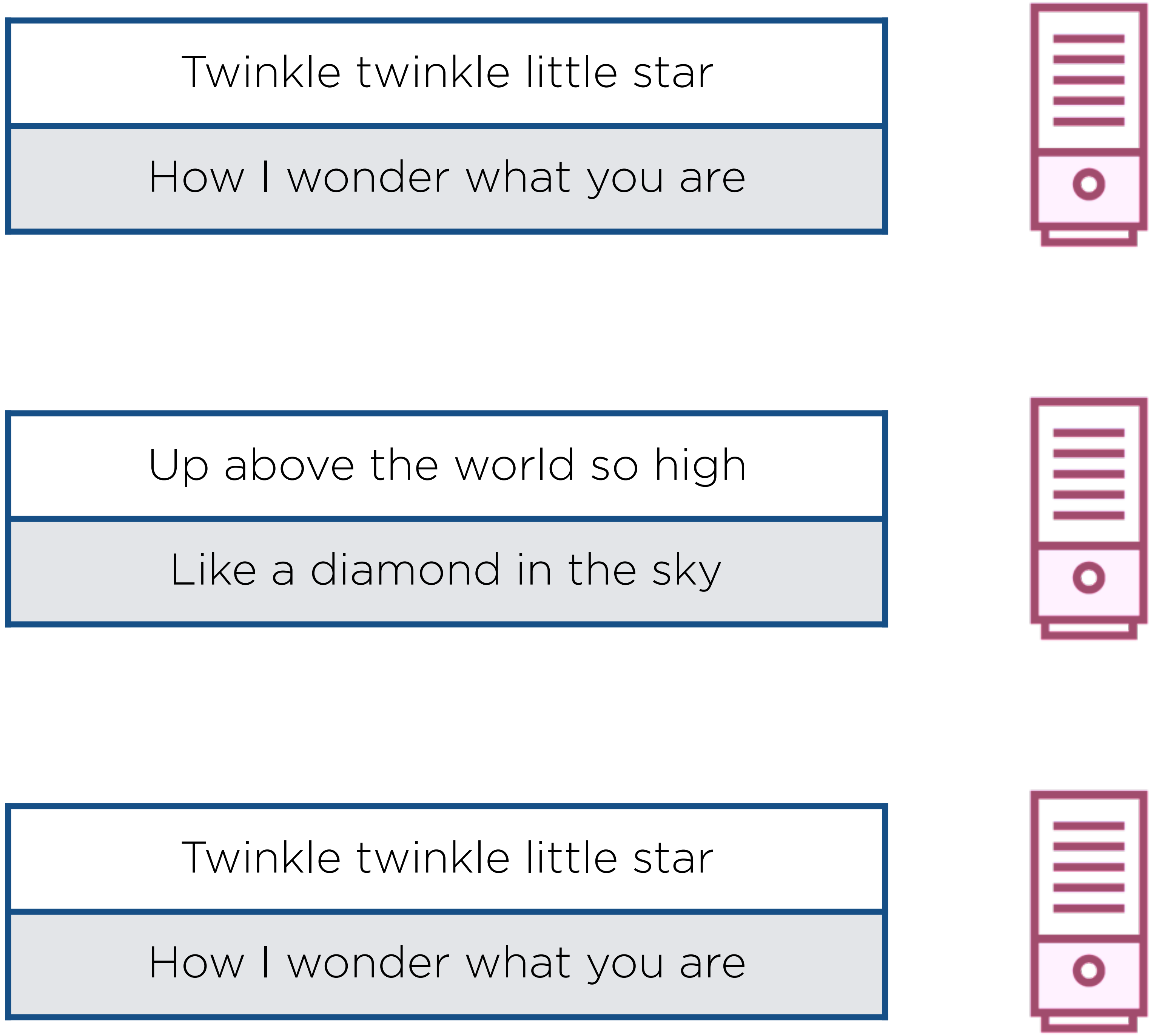
.....

The raw data is really large (potentially in PetaBytes)

It’s distributed across many machines in a cluster

Each machine holds a partition of data

MapReduce Flow



Twinkle twinkle little star

How I wonder what you are

Up above the world so high

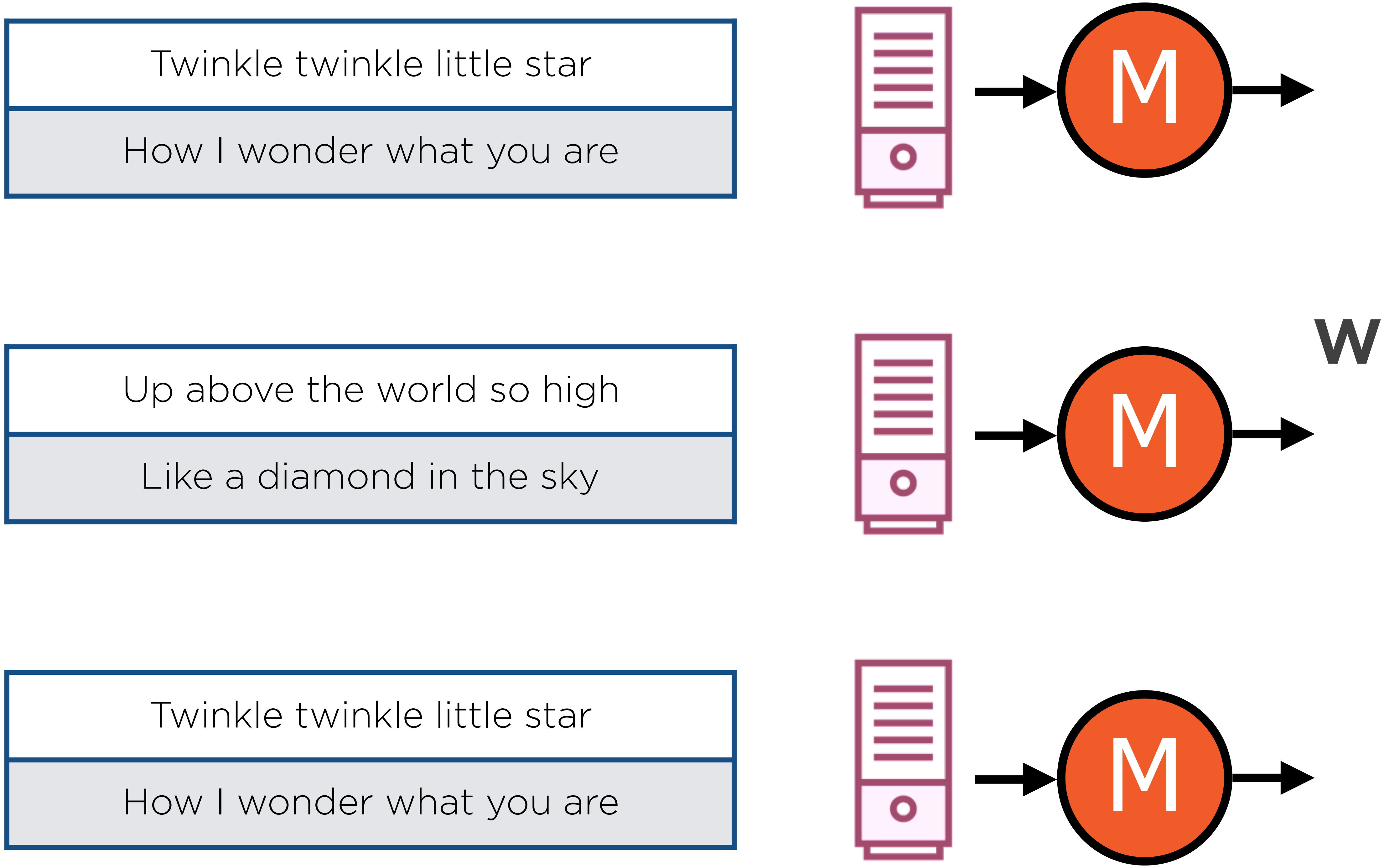
Like a diamond in the sky

Twinkle twinkle little star

How I wonder what you are

Each partition is given to a different process i.e. to mappers

MapReduce Flow



Twinkle twinkle little star

How I wonder what you are

Up above the world so high

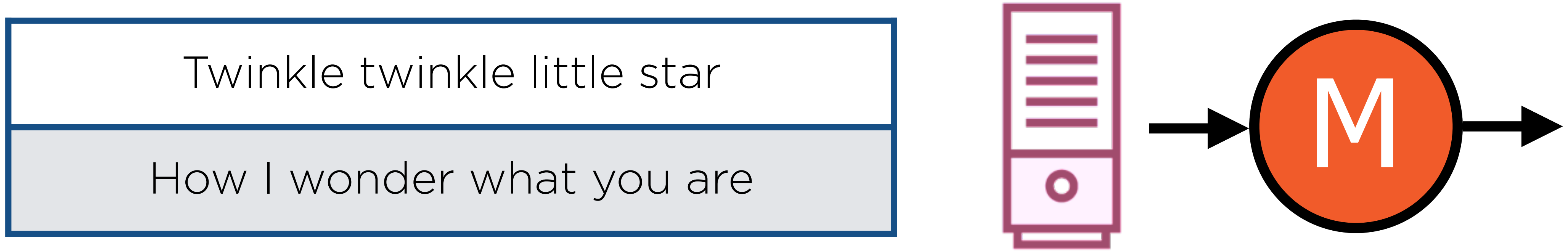
Like a diamond in the sky

Twinkle twinkle little star

How I wonder what you are

Each mapper works in parallel

Map Flow

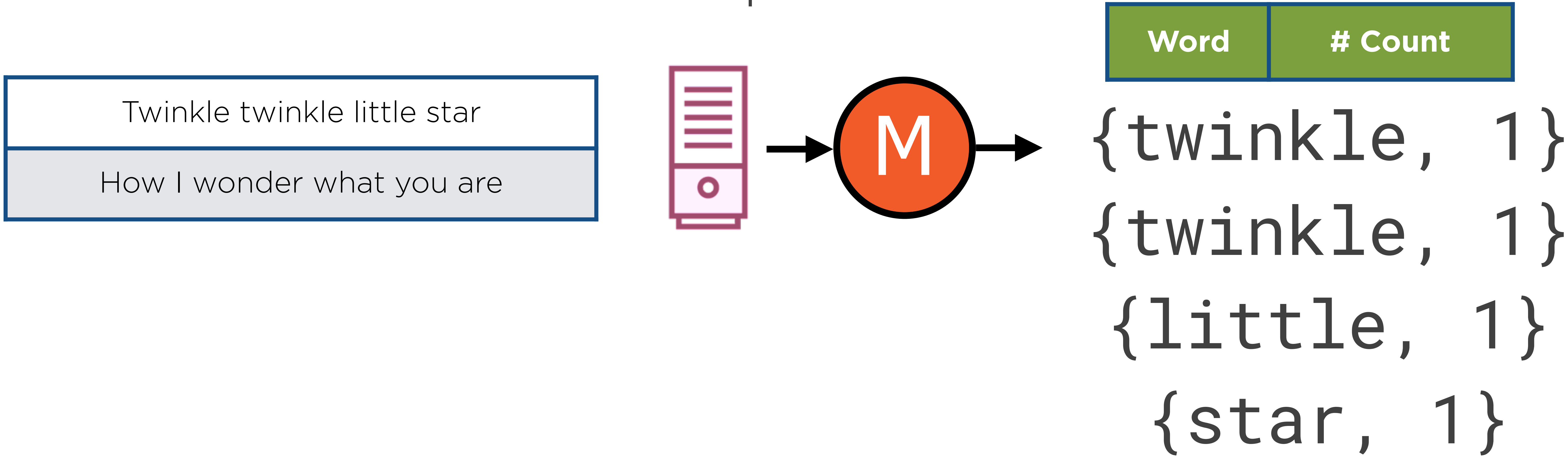


Twinkle twinkle little star

How I wonder what you are

Within each mapper, the rows are processed serially

Map Flow



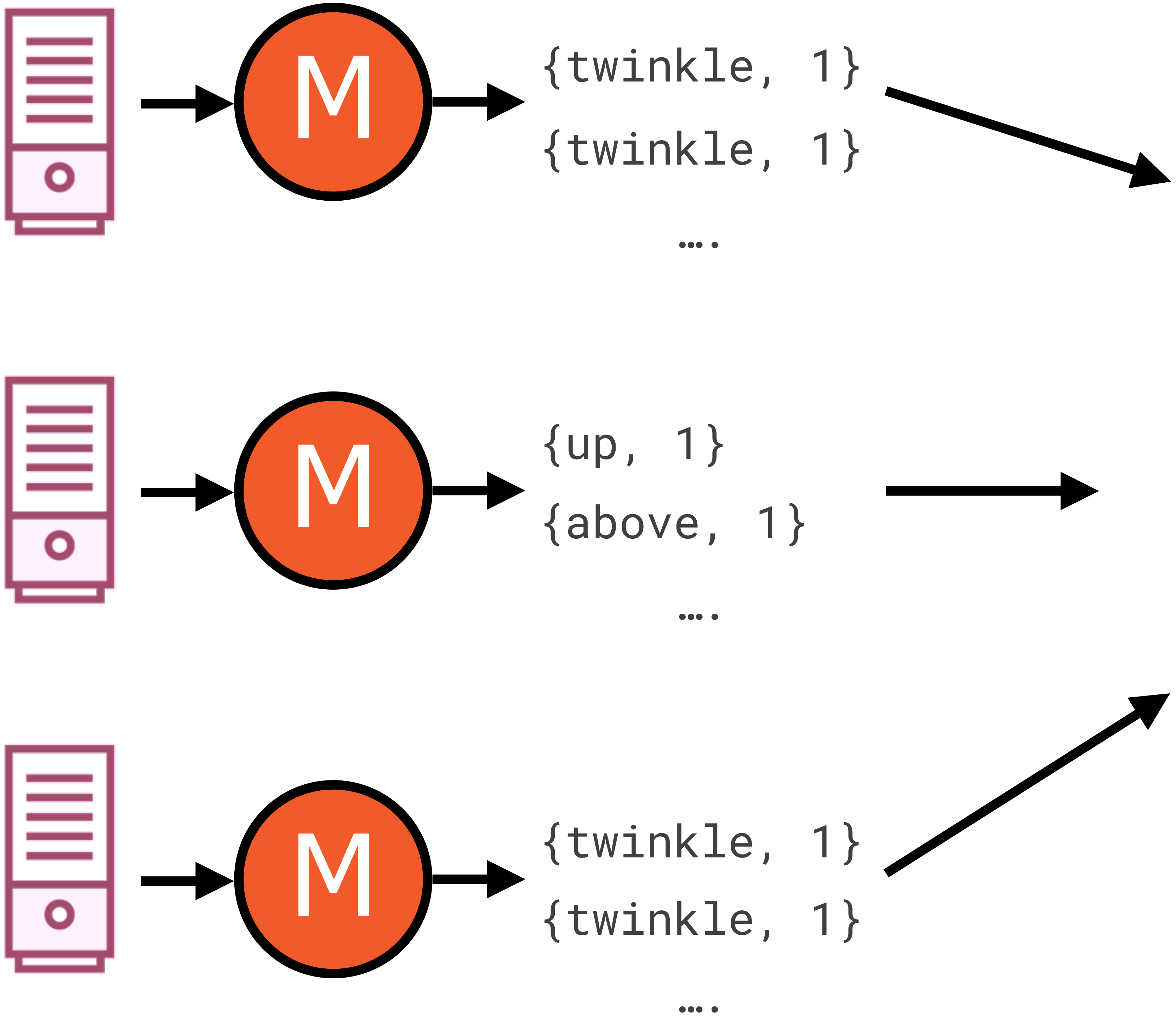
Twinkle twinkle little star
How I wonder what you are

Word	# Count

{twinkle, 1}
{twinkle, 1}
{little, 1}
{star, 1}

Each row emits {key, value} pairs

Reduce Flow



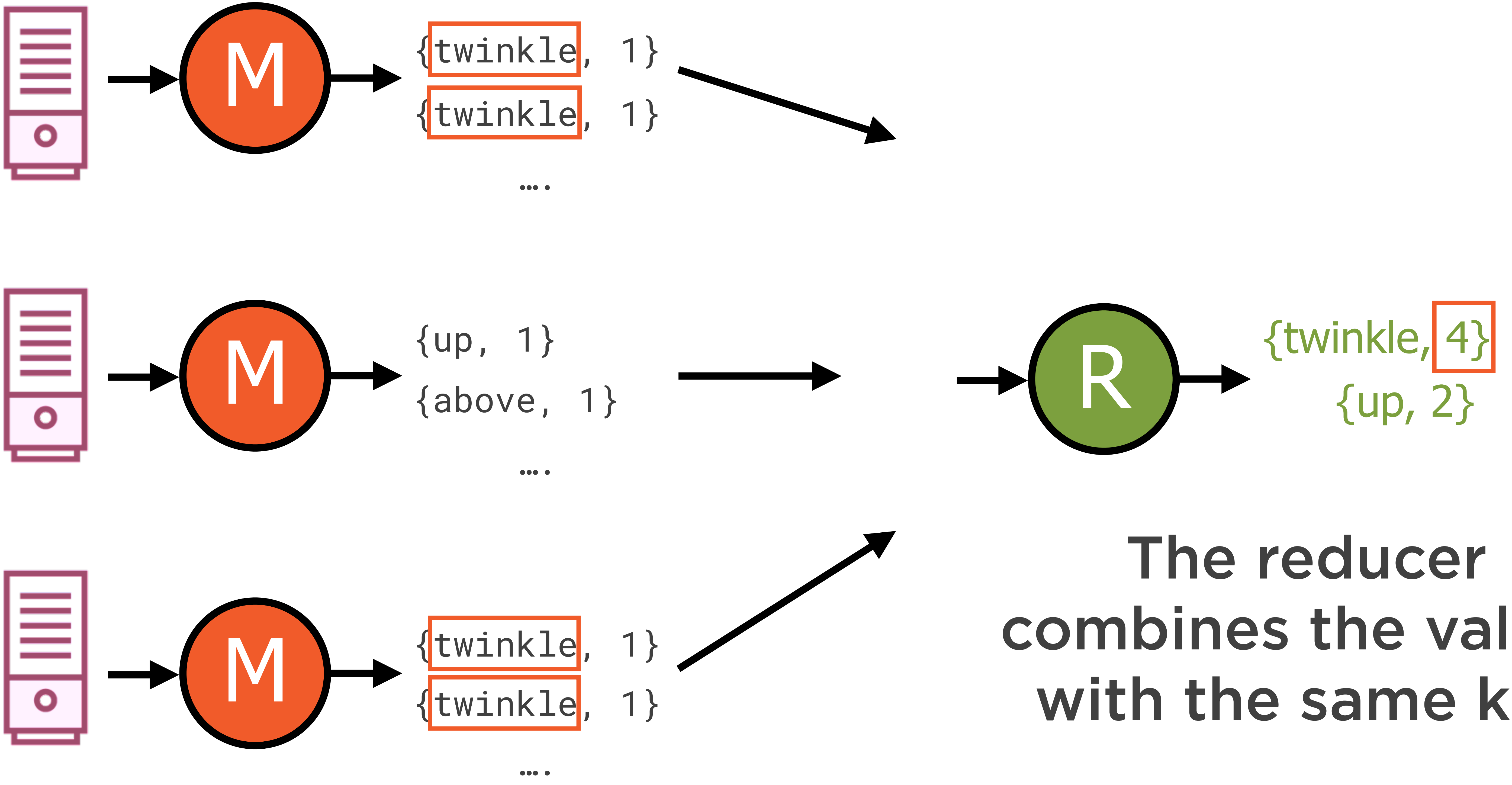
{twinkle, 1}
{twinkle, 1}
….

{up, 1}
{above, 1}
….

{twinkle, 1}
{twinkle, 1}
….

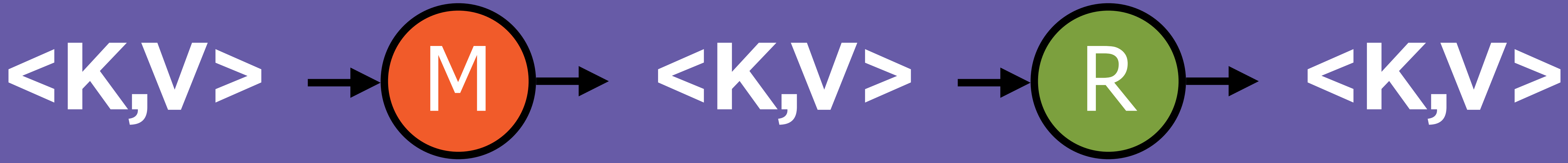
The results are passed on to another process i.e. a reducer

Reduce Flow



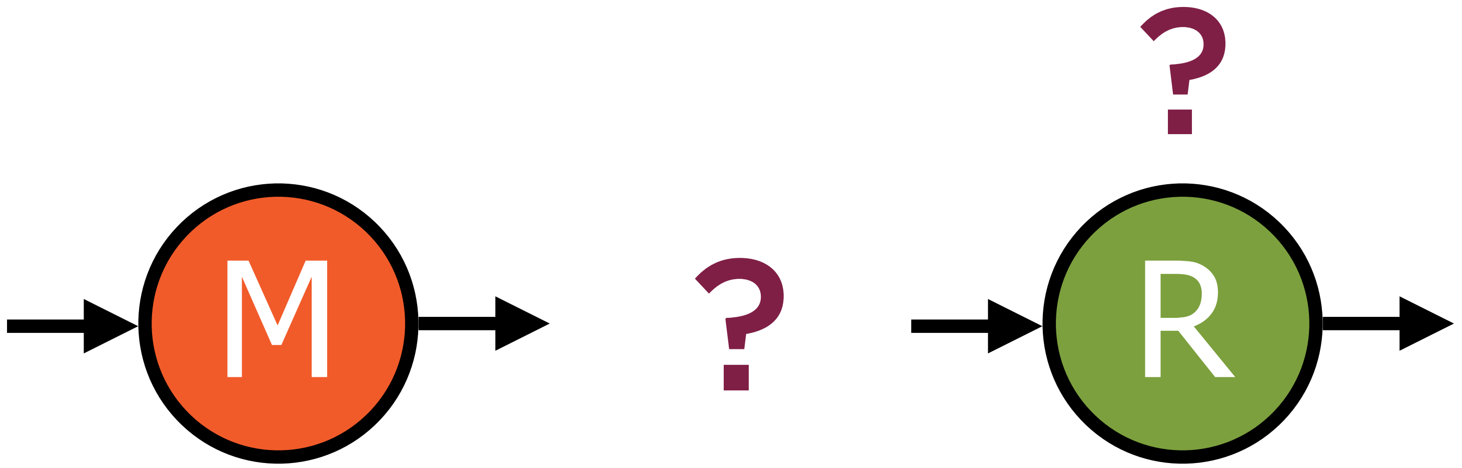
The reducer combines the values with the same key

Key Insight Behind MapReduce



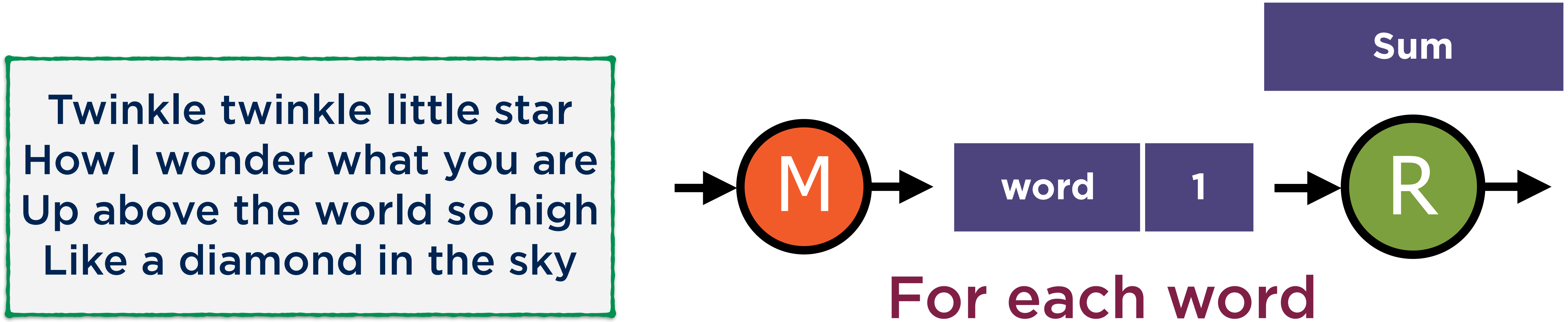
Many data processing tasks can be expressed in this form

Answer Two Questions



1. What {key, value} pairs should be emitted in the map step?
2. How should values with the same key be combined?

Counting Word Frequencies



Twinkle twinkle little star
How I wonder what you are
Up above the world so high
Like a diamond in the sky

M

word | 1

Sum

R

Word	Count
twinkle	2
little	1
...	...
...	...
...	...
...	...

For each word in each line

```
{twinkle, 1}
{twinkle, 1}
{little, 1}
{star, 1}
..
```

...

Answer these to parallelize any task :)

Implementing in Java

Map

A class where the map logic is implemented

Reduce

A class where the reduce logic is implemented

Main

A driver program that sets up the job

Implementing in Java

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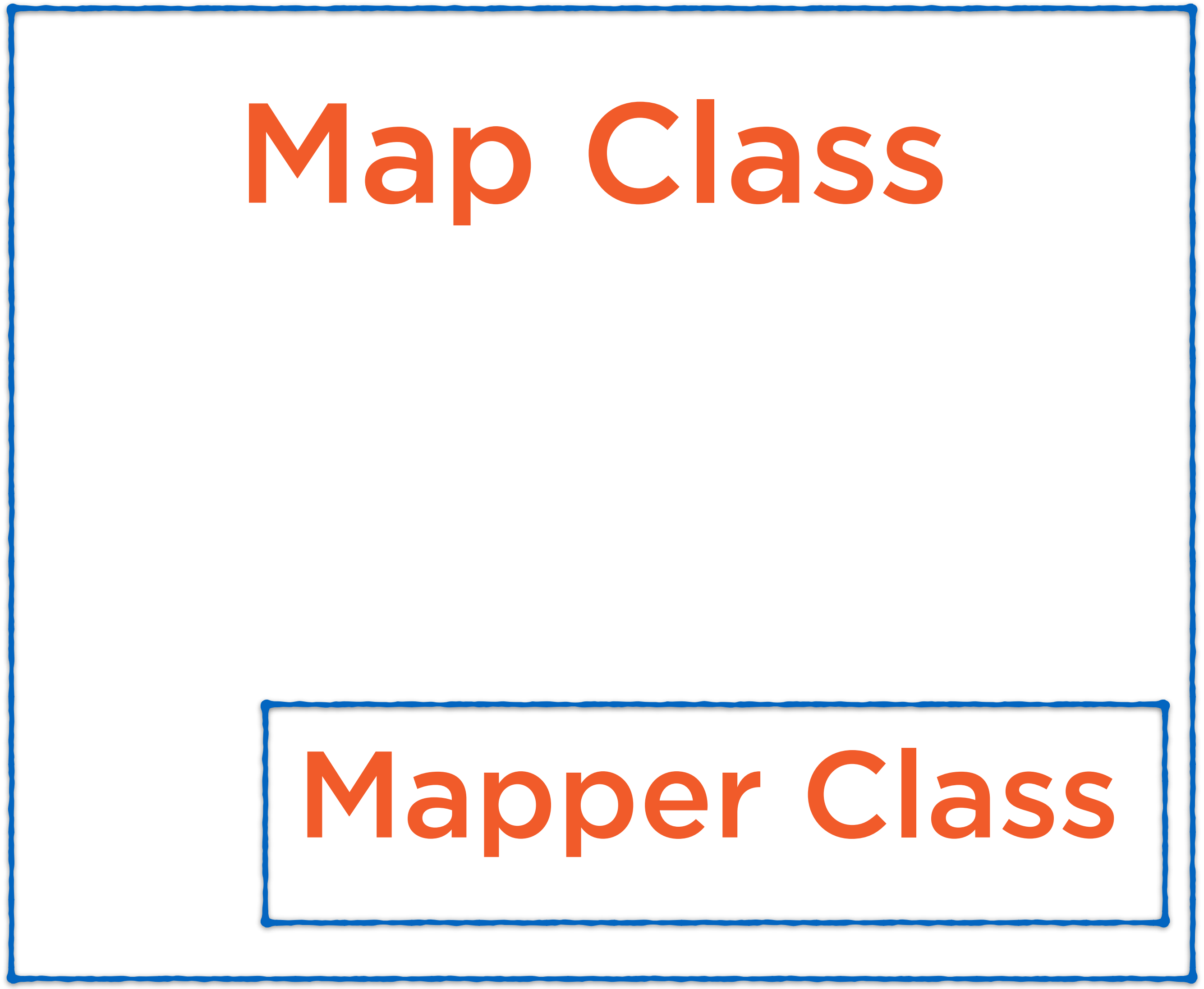
Map Step

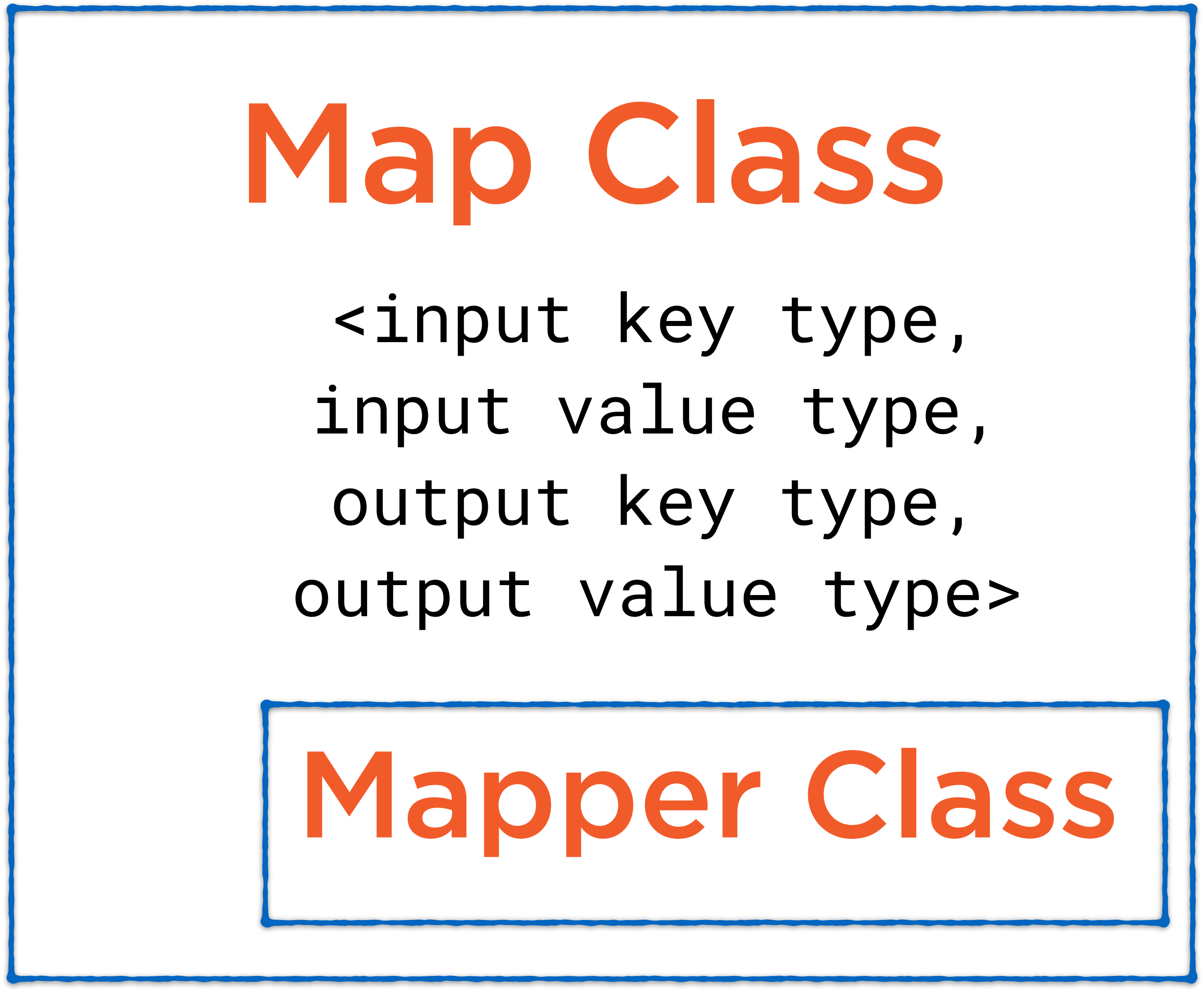


Map Class

Mapper Class

The map logic is implemented in a class that extends the Mapper Class

Map Step



Map Class

```
 <input key type,
input value type,
 output key type,
output value type>
```

Mapper Class

This is a generic class, with 4 type parameters

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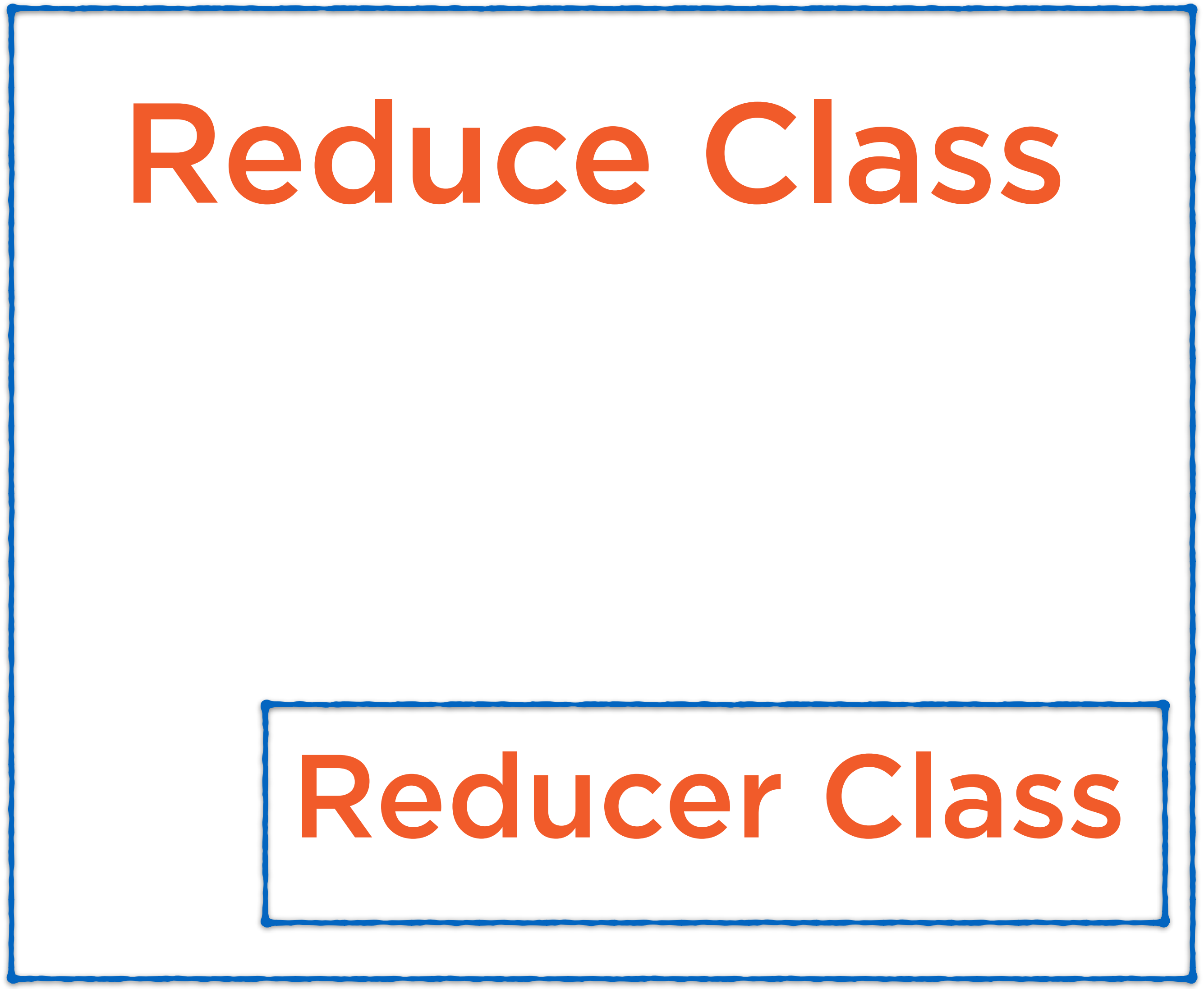
Reduce Step

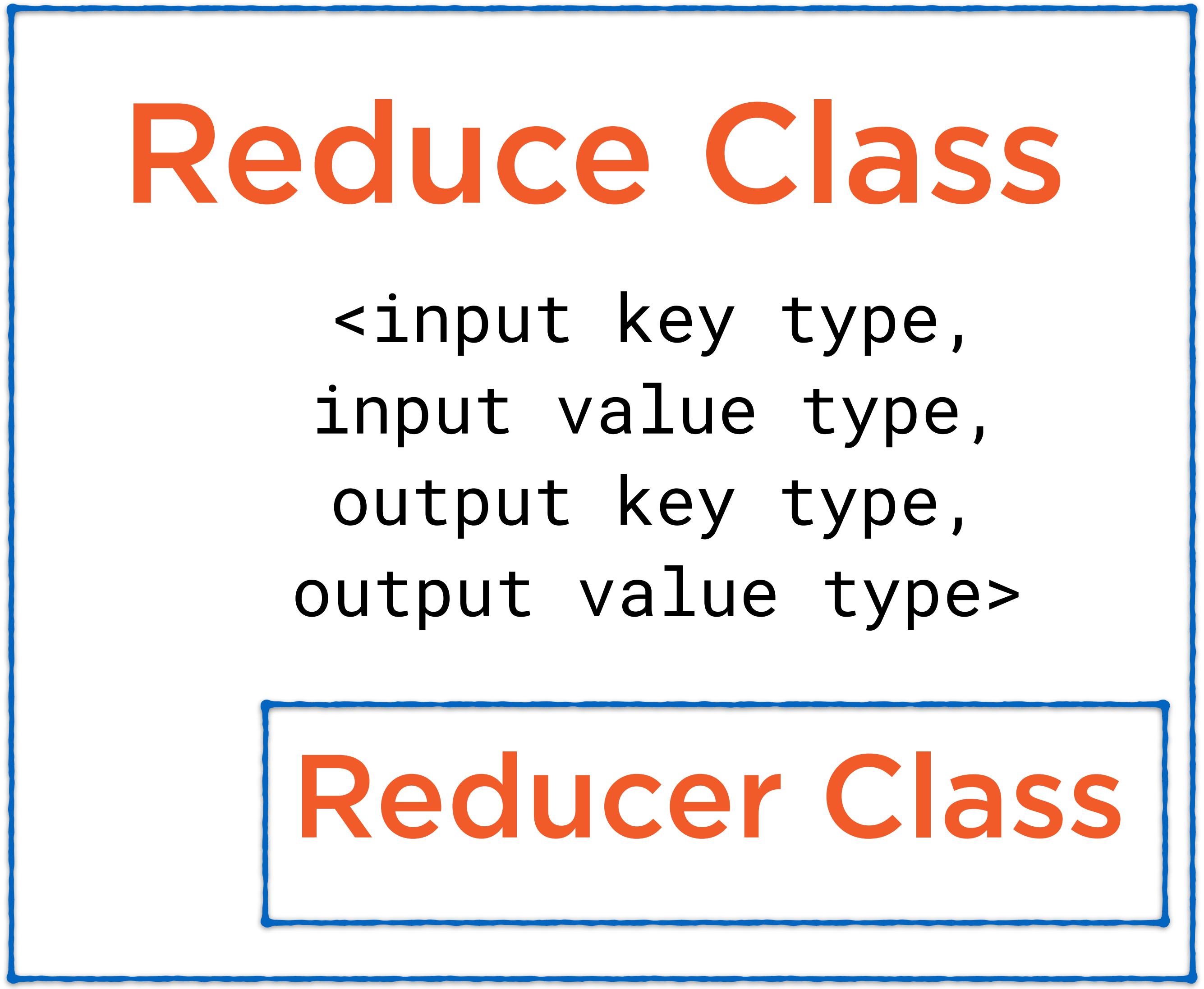


Reduce Class

Reducer Class

The reduce logic is implemented in a class that extends the Reducer Class

Reduce Step



Reduce Class

```
<input key type,
input value type,
output key type,
output value type>
```

Reducer Class

This is also a generic class, with 4 type parameters

Matching Data Types

Map Class

output key type,
output value type>

Mapper Class

Reduce Class

<input key type,
input value type,

Reducer Class

The output types of the Mapper should match the input types of the Reducer

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Implementing in Java

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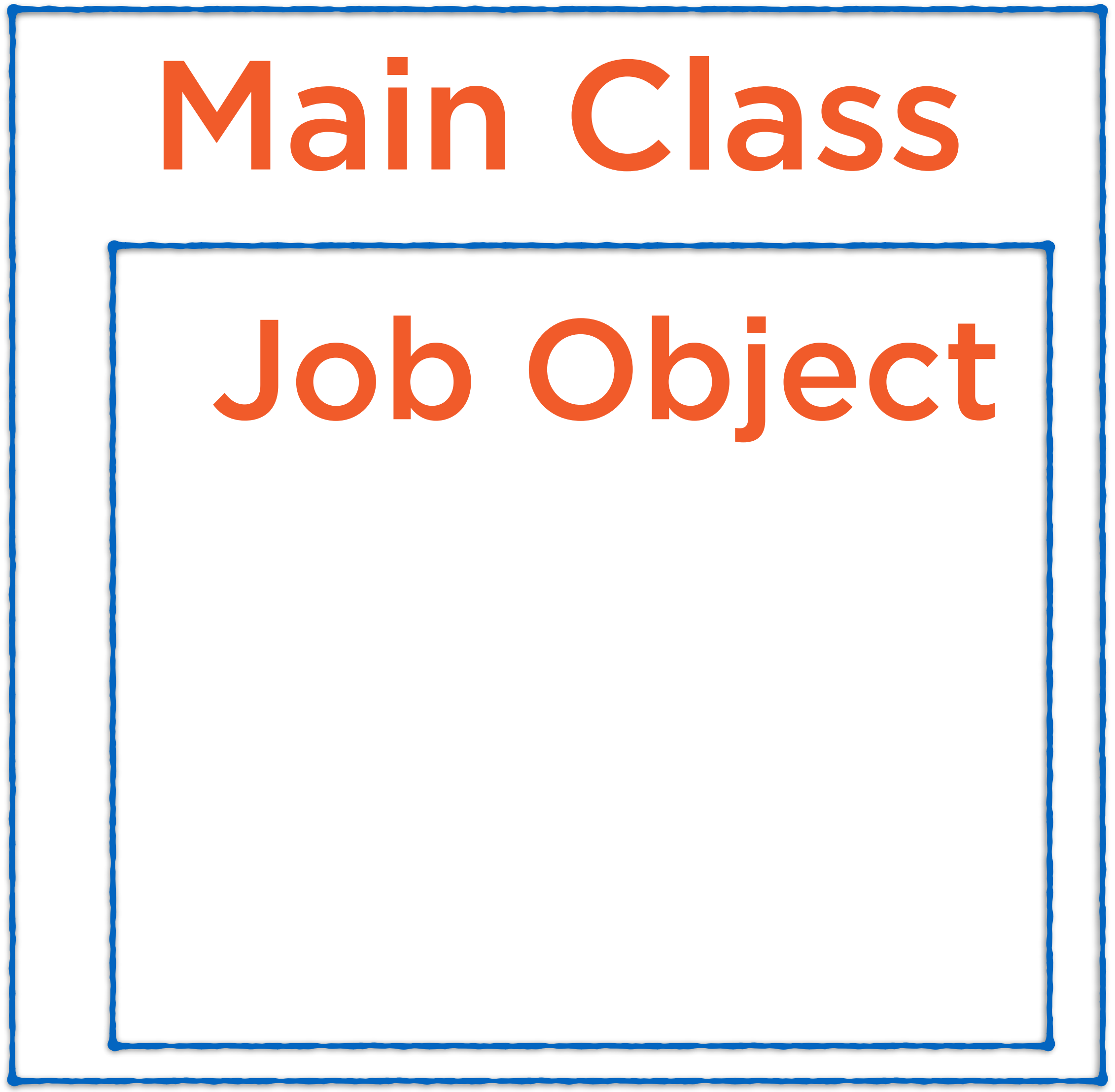
A class where the reduce logic is implemented

Main

A driver program that sets up the job

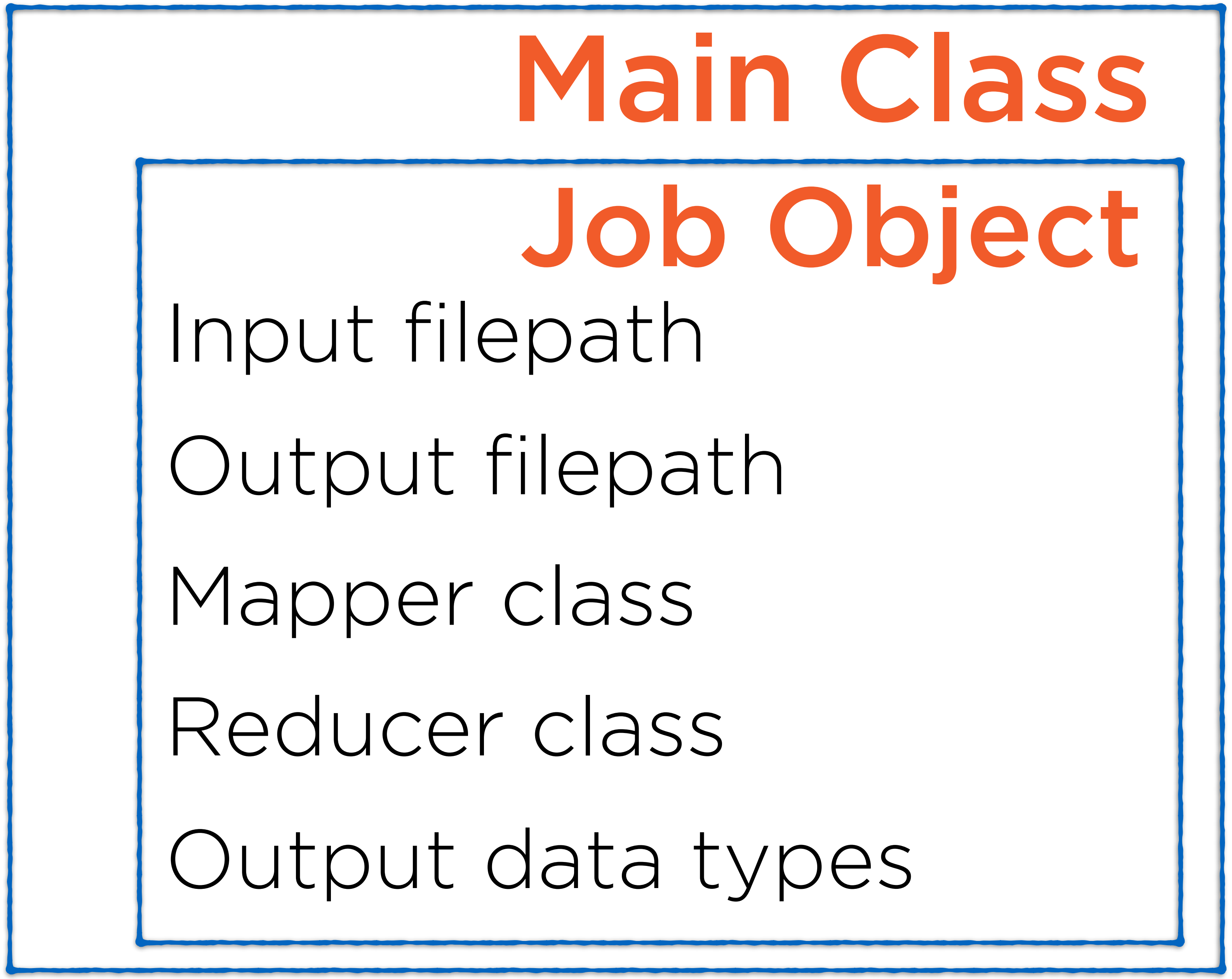
Setting up the Job

The Mapper and Reducer classes are used by a Job that is configured in the Main Class



Setting up the Job

The Job has a bunch of properties that need to be configured



Main Class

Job Object

Input filepath

Output filepath

Mapper class

Reducer class

Output data types

Demo

Running a MapReduce job

Monitoring progress in the UI

Understanding the information presented in the UI

Summary

Setting up a MapReduce job for a simple counting task

Submitting a MapReduce job to Hadoop and monitoring it