Data-Parallel to Distributed Data-Parallel

Big Data Analysis with Scala and Spark

Heather Miller

Visualizing **Shared Memory** Data Parallelism

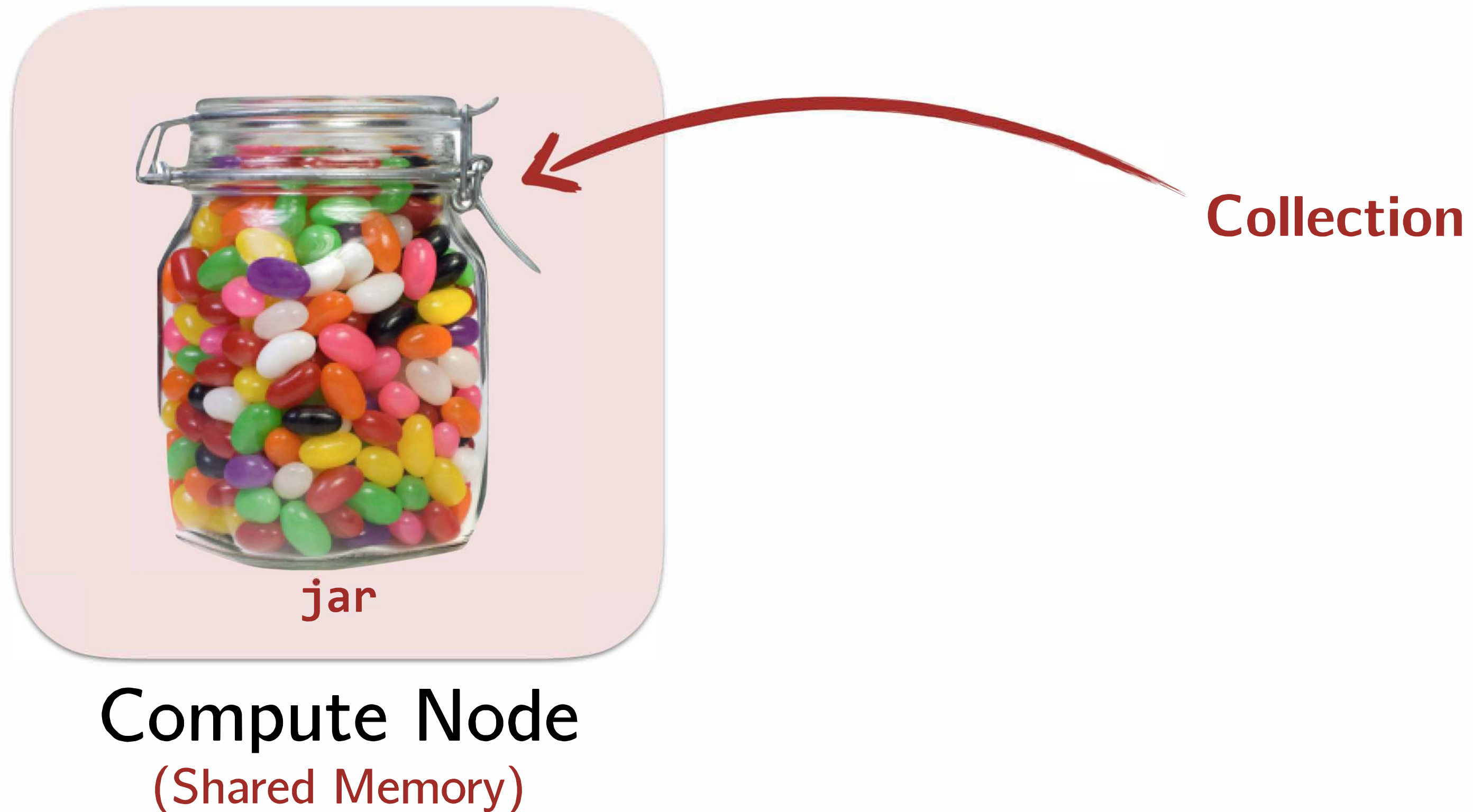What does data-parallel look like?

What does data-parallel look like?

Compute Node
(Shared Memory)

What does data-parallel look like?

Collection

jar
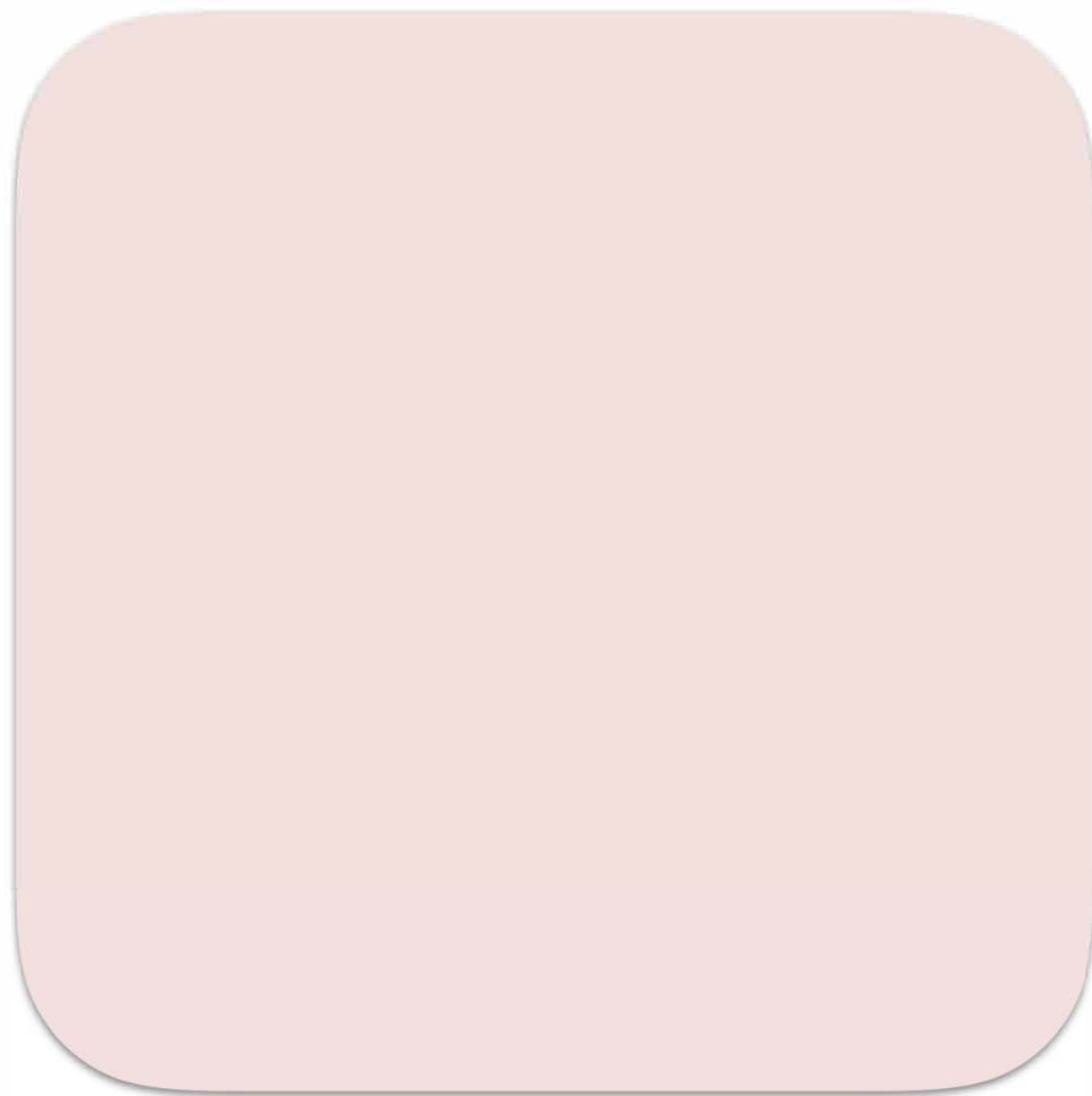
Compute Node
(Shared Memory)

Visualizing **Shared Memory** Data Parallelism

What does data-parallel look like?

```scala
val res =
  jar.map(jellyBean => doSomething(jellyBean))
```


jar

Collection

Compute Node
(Shared Memory)

Visualizing **Shared Memory** Data Parallelism

What does data-parallel look like?

```
val res =
  jar.map(jellyBean => doSomething(jellyBean))
```


jar

Compute Node
(Shared Memory)

Shared memory data parallelism:

▸ Split the data.

▸ Workers/threads independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

What does data-parallel look like?

```
val res =
  jar.map(jellyBean => doSomething(jellyBean))
```


jar

Compute Node
(Shared Memory)

Shared memory data parallelism:

▸ Split the data.

▸ Workers/threads independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

Visualizing **Shared Memory** Data Parallelism

What does data-parallel look like?

```
val res =
  jar.map(jellyBean => doSomething(jellyBean))
```
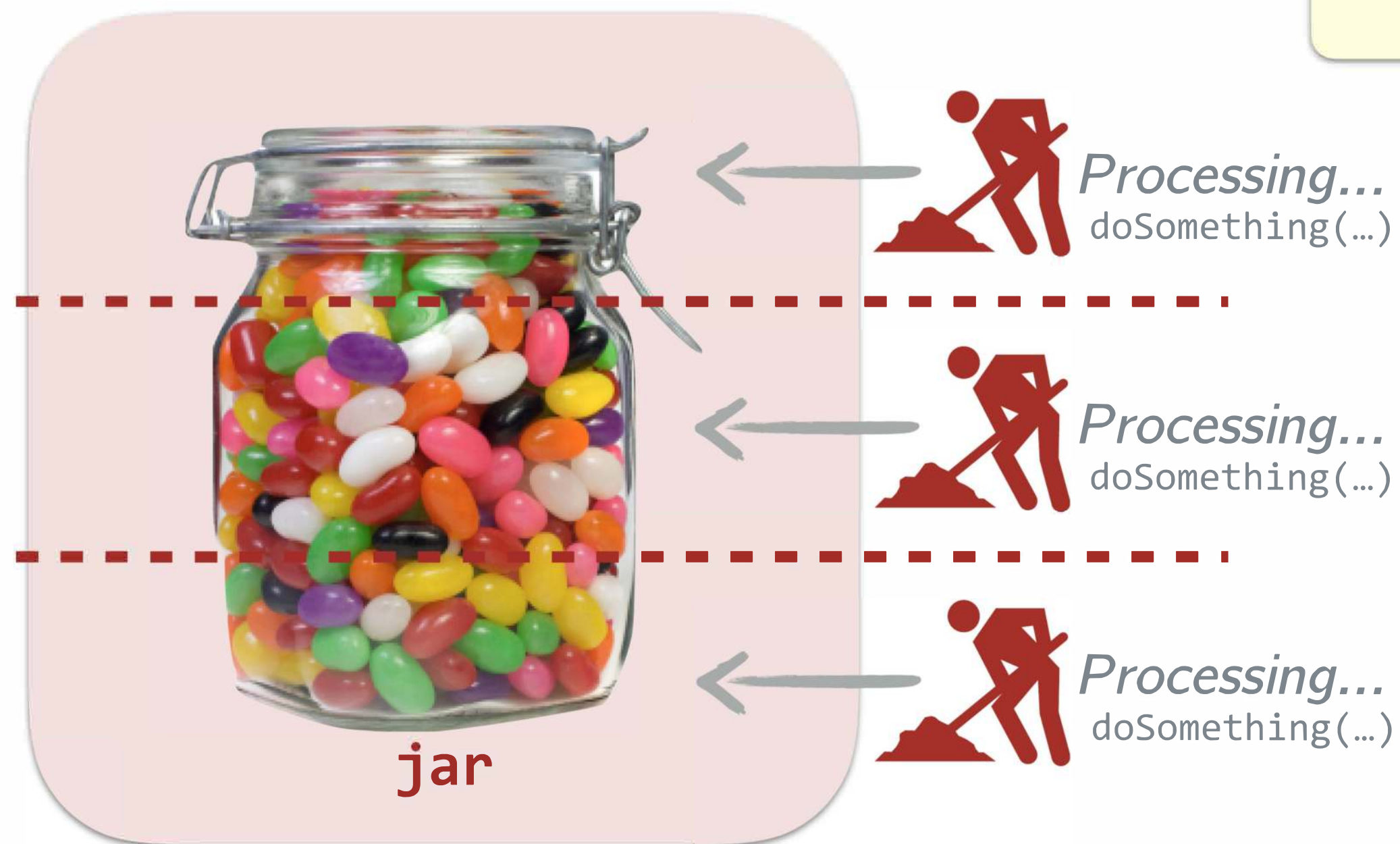

jar

Compute Node
(Shared Memory)

Shared memory data parallelism:

▸ Split the data.

▸ Workers/threads independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

Visualizing **Shared Memory** Data Parallelism

What does data-parallel look like?

```
val res =
    jar.map(jellyBean => doSomething(jellyBean))
```


jar

Compute Node
(Shared Memory)

Processing...
doSomething(...)

Processing...
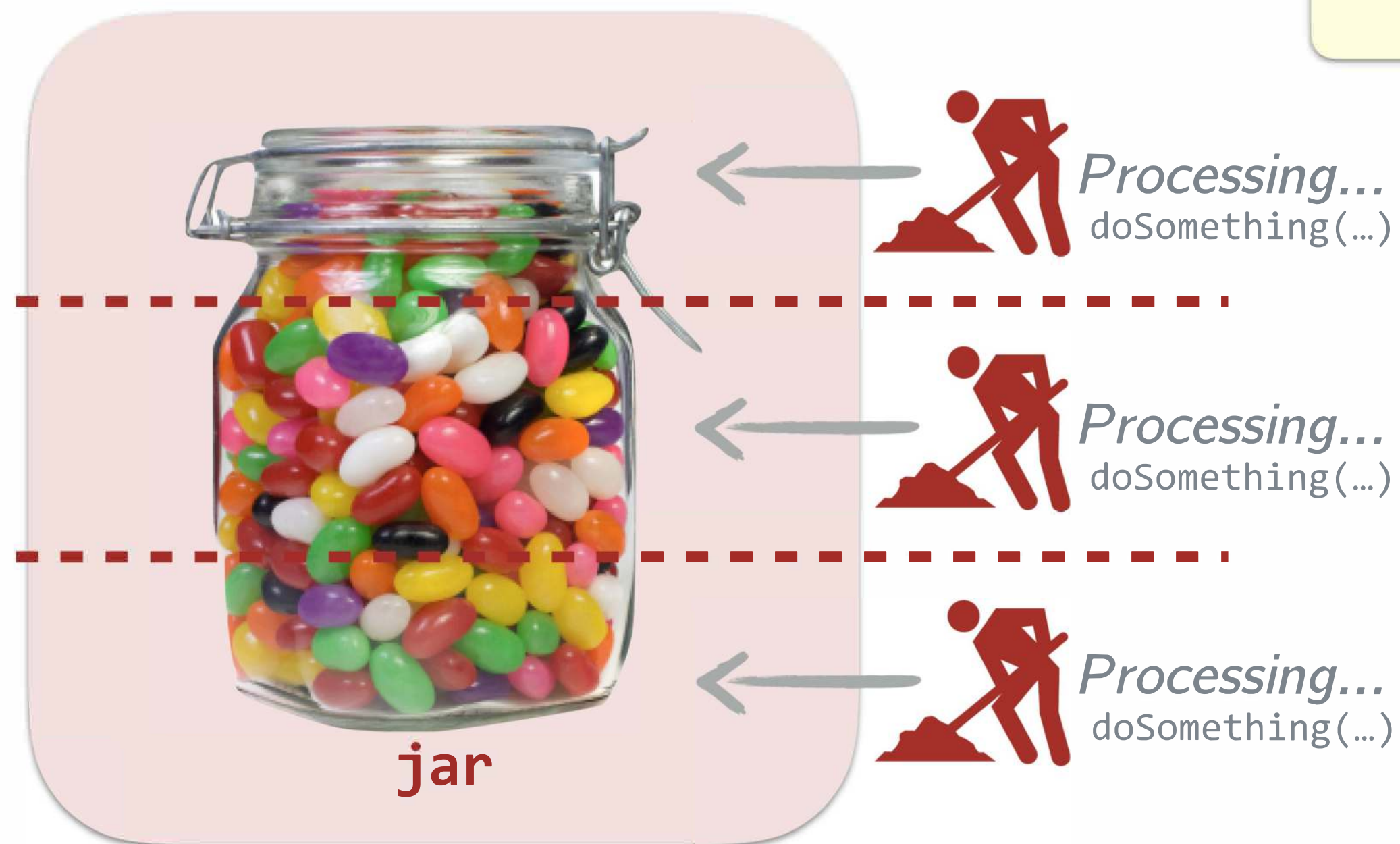doSomething(...)

Processing...
doSomething(...)

Shared memory data parallelism:

▸ Split the data.

▸ Workers/threads independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

What does data-parallel look like?

```scala
val res =
  jar.map(jellyBean => doSomething(jellyBean))
```


Processing...
doSomething(...)

Processing...
doSomething(...)

Processing...
doSomething(...)

jar

Compute Node
(Shared Memory)

Shared memory data parallelism:

▸ Split the data.

▸ Workers/threads independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

Scala's Parallel Collections is a collections abstraction over shared memory data-parallel execution.

What does **distributed** data-parallel look like?

Shared memory data parallelism:

▸ Split the data.

▸ Workers/threads independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

What does **distributed** data-parallel
look like?

Distributed
~~Shared-memory~~ **data parallelism:**

- ▸ Split the data over several nodes.
- ▸ Nodes independently operate on the data shards in parallel.
- ▸ Combine when done (if necessary).

What does **distributed** data-parallel
look like?

Distributed **data parallelism:**

▸ Split the data over several nodes.

▸ Nodes independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

Visualizing **Distributed** Data-Parallelism

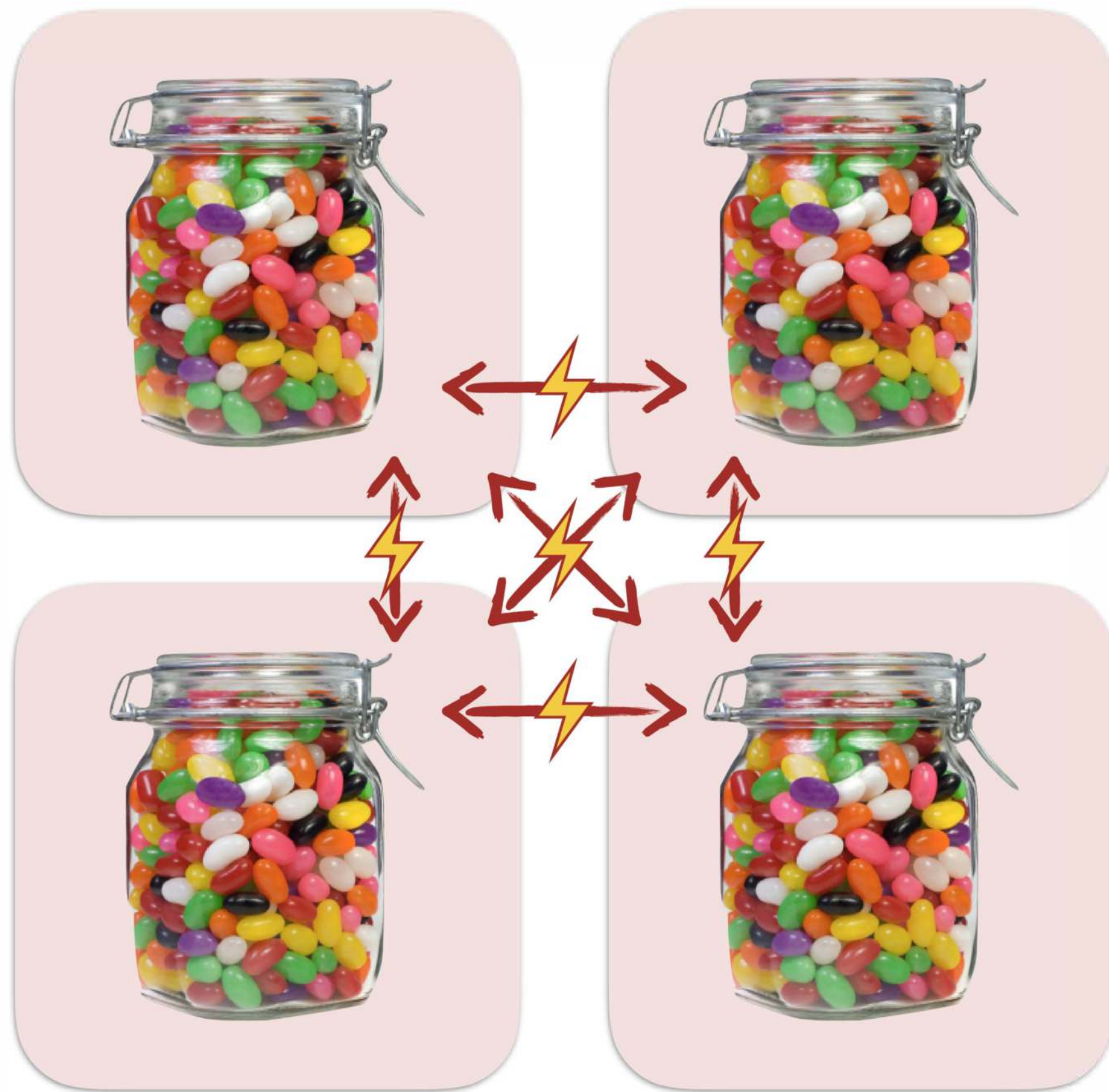What does **distributed** data-parallel look like?

Distributed data parallelism:

▸ Split the data over several nodes.

▸ Nodes independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

What does **distributed** data-parallel
look like?

Distributed data parallelism:

▸ Split the data over several nodes.

▸ Nodes independently operate on the
data shards in parallel.

▸ Combine when done (if necessary).

New concern:

Now we have to worry about
network latency between workers.

Visualizing **Distributed** Data-Parallelism

What does **distributed** data-parallel look like?


```
val res =
  jar.map(jellyBean => doSomething(jellyBean))
```
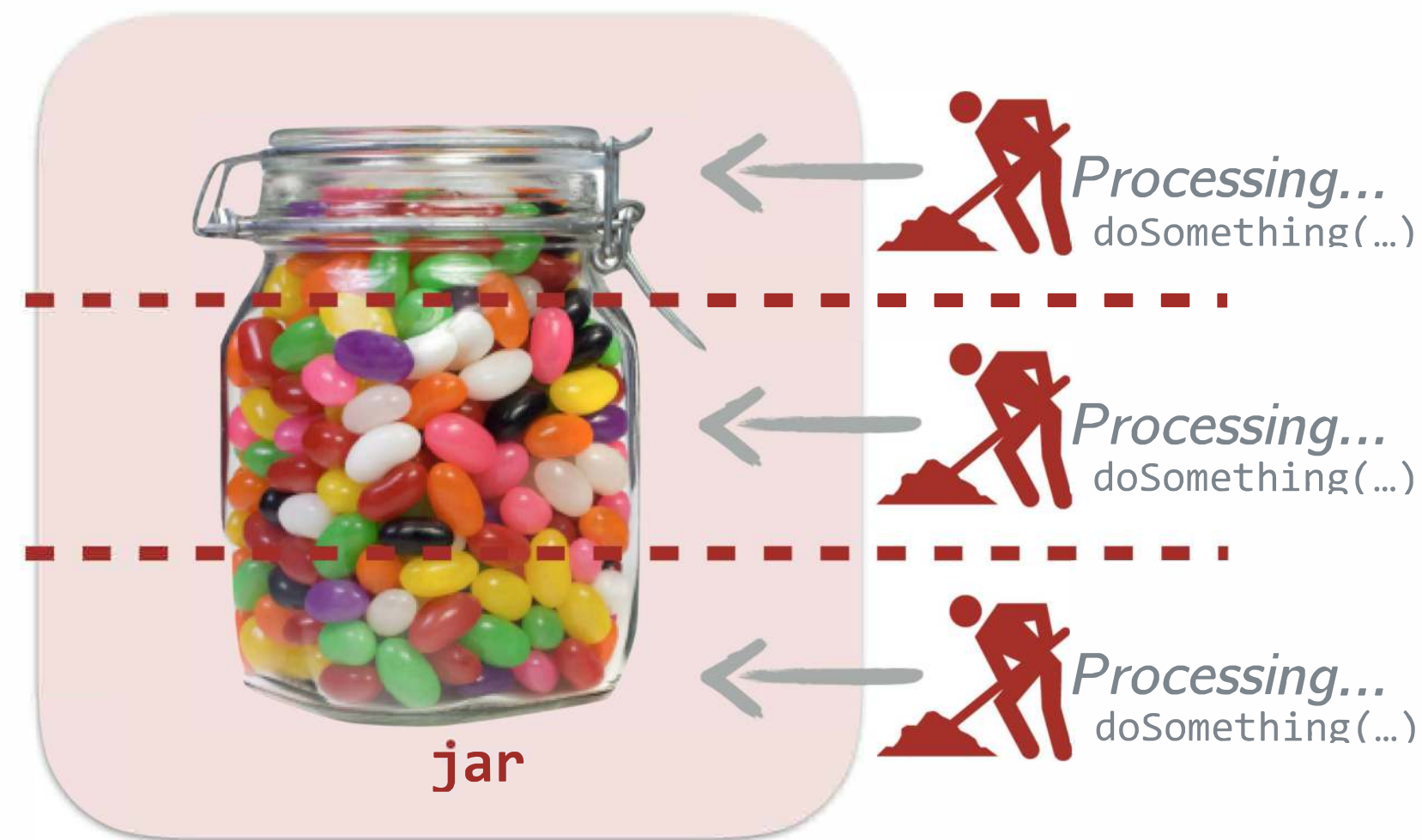
Distributed data parallelism:

▸ Split the data over several nodes.

▸ Nodes independently operate on the data shards in parallel.

▸ Combine when done (if necessary).

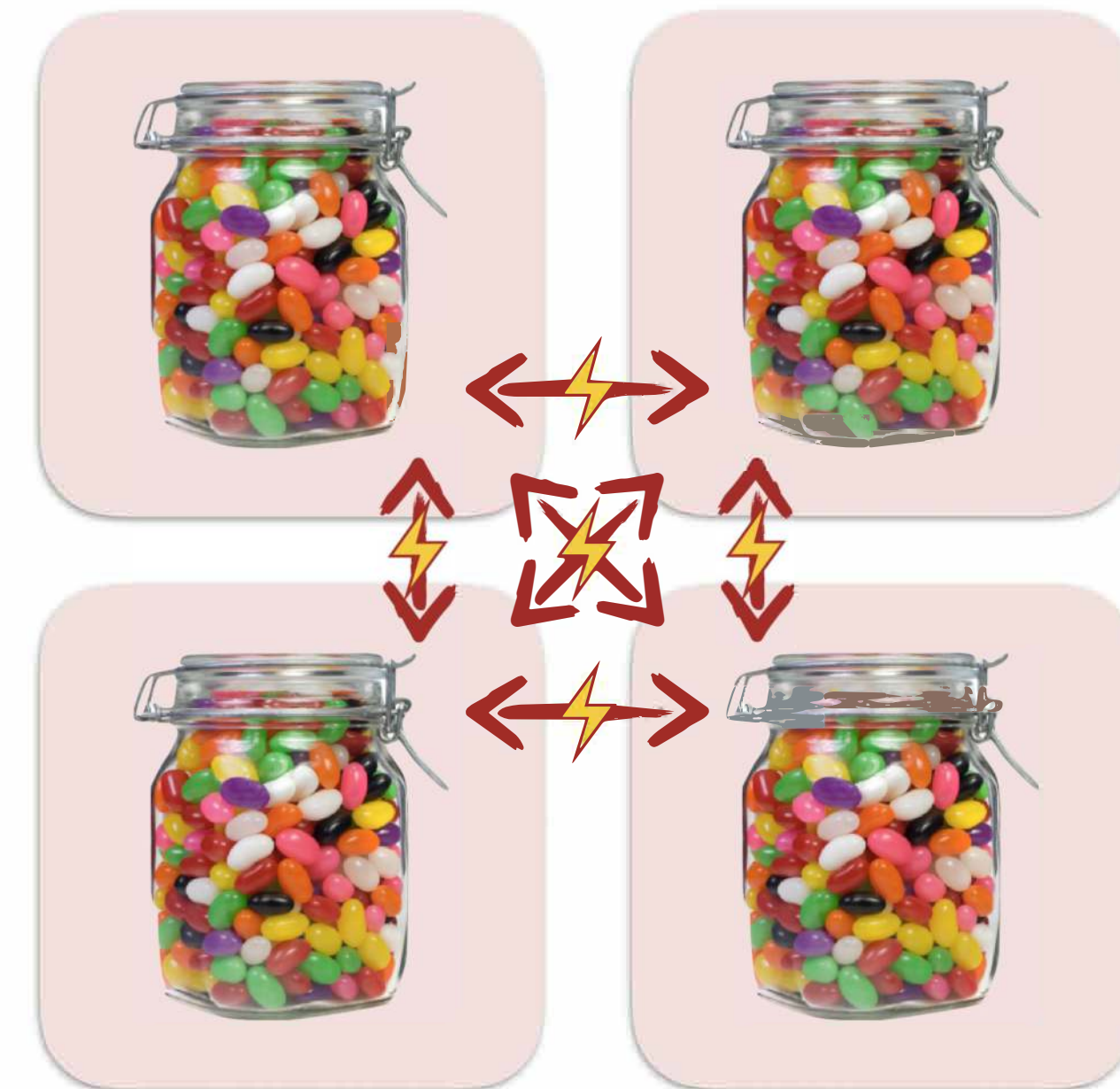However, like parallel collections, we can keep collections abstraction over distributed data-parallel execution.
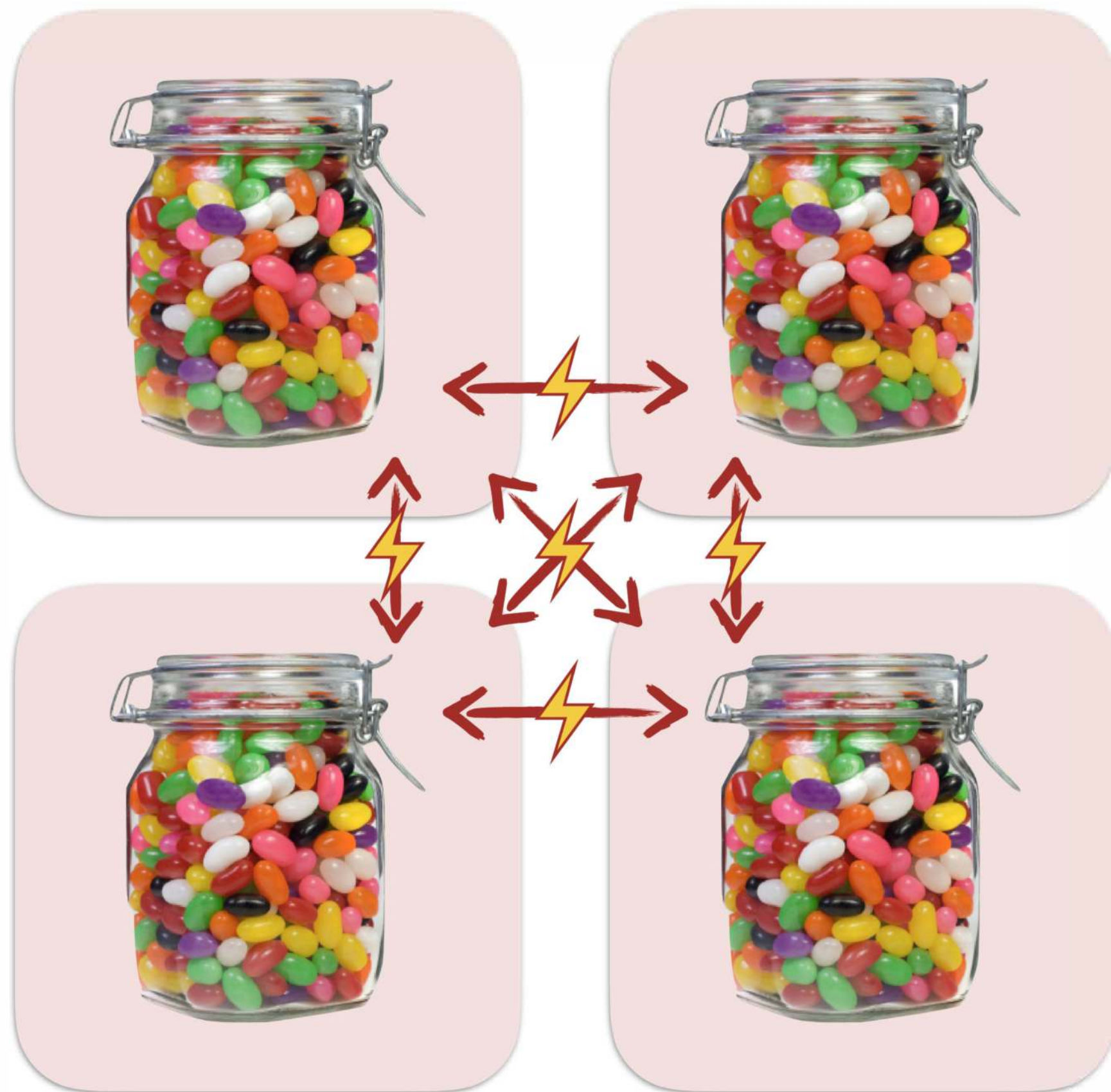
Data-Parallel to **Distributed** Data-Parallel
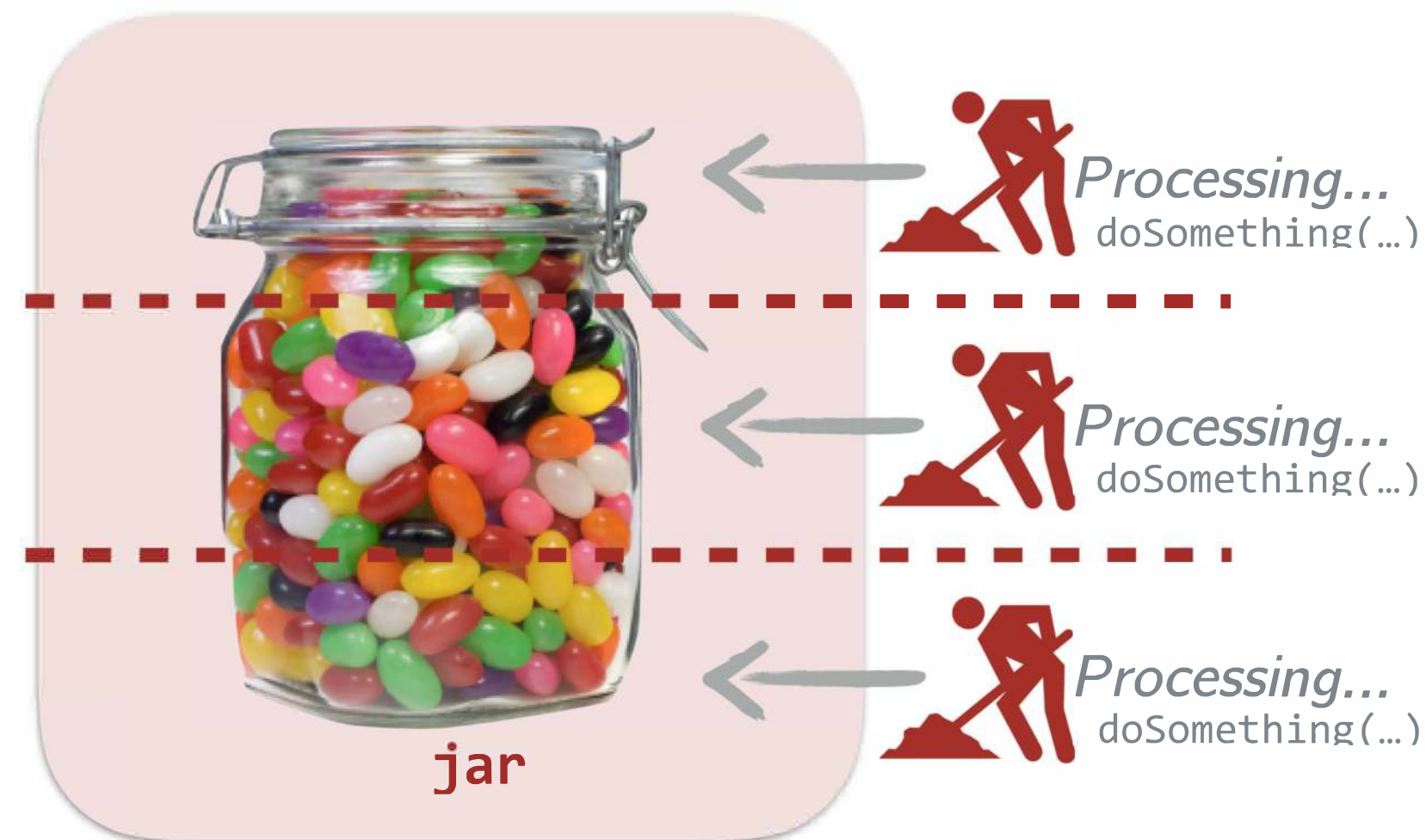
Shared memory:

Distributed:

Shared memory case: Data-parallel programming model. Data partitioned in memory and operated upon in parallel.

Distributed case: Data-parallel programming model. Data partitioned between machines, network in between, operated upon in parallel.

Data-Parallel to **Distributed** Data-Parallel

Shared memory:

jar

Distributed:

Overall, most all properties we learned about related to shared memory data-parallel collections can be applied to their distributed counterparts. *E.g., watch out for non-associative reduction operations!*

.reduce(_-_)

However, must now consider **latency** when using our model.

Apache Spark

Throughout this part of the course we will use the **Apache Spark** framework for distributed data-parallel programming.

Spark implements a distributed data parallel model called
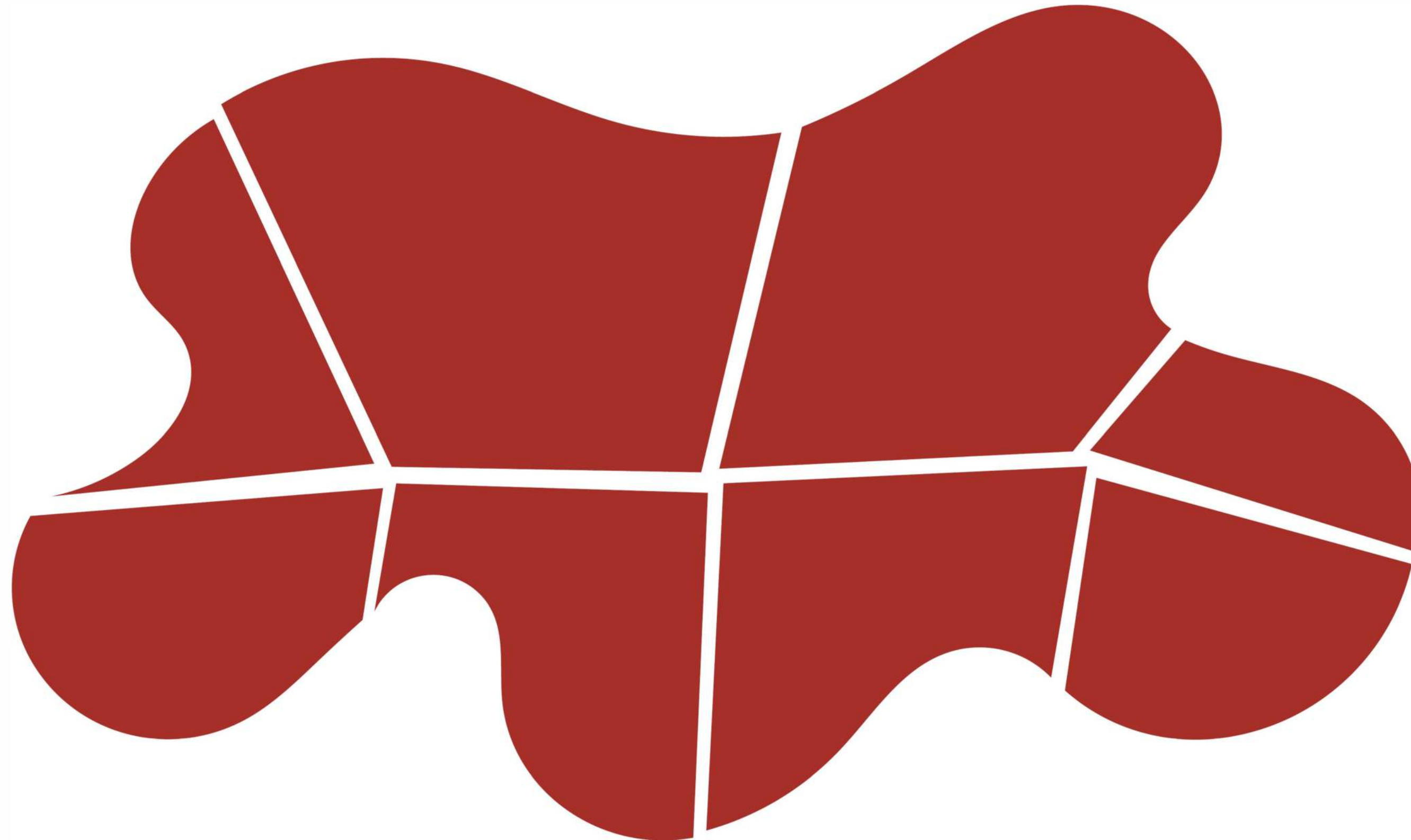**Resilient Distributed Datasets (RDDs)**

Given some large dataset that can't fit into memory on a single node...

Chunk up the data...

Chunk up the data...

Distributed Data-Parallel: High Level Illustration
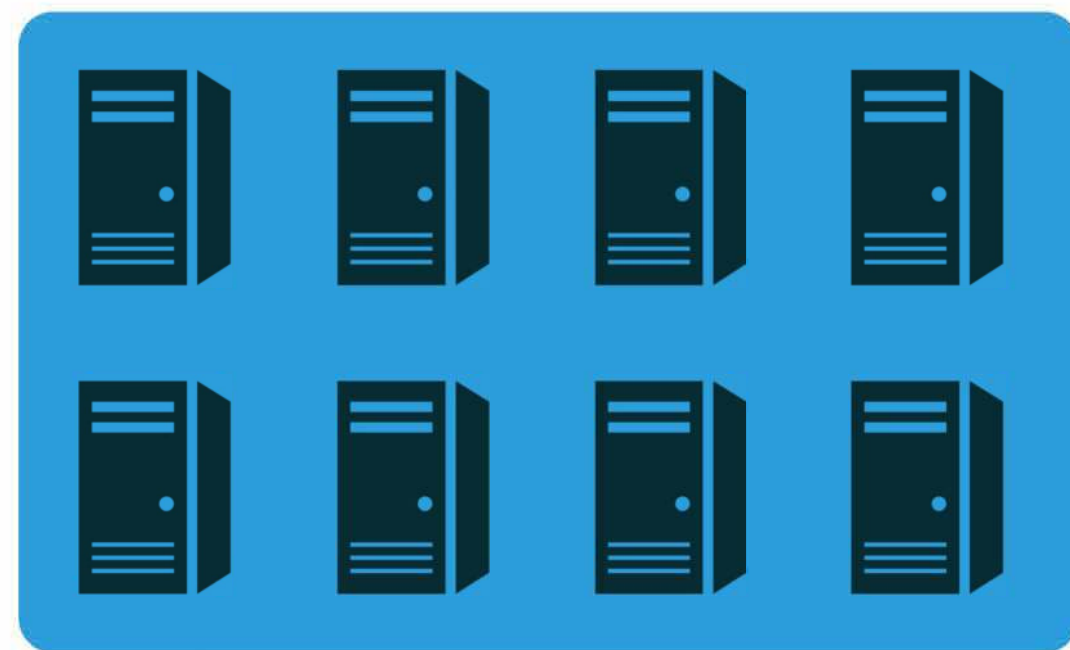
Distribute it over your cluster of machines.
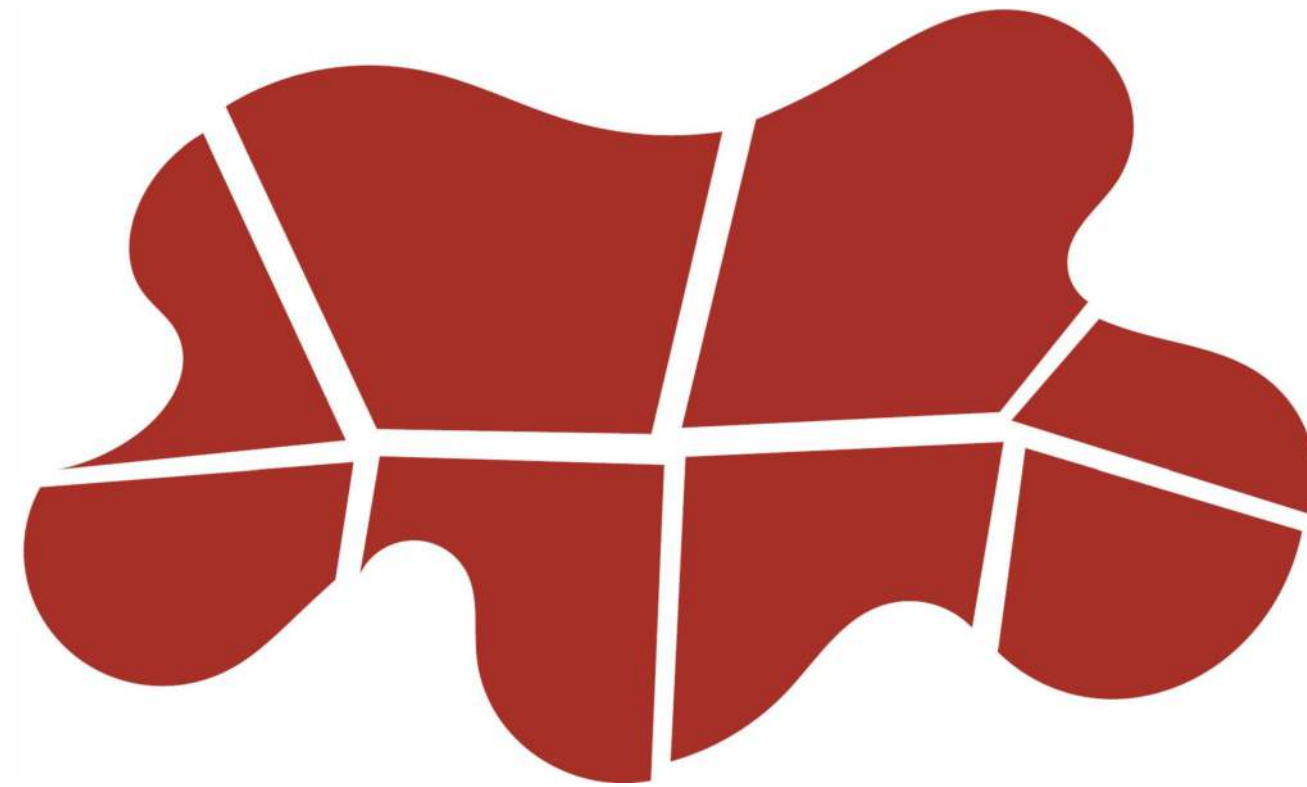
Distribute it over your cluster of machines.

Distributed Data-Parallel: High Level Illustration

From there, think of your distributed data like a single collection...

Example:

Transform the text (not titles) of all wiki articles to lowercase.

```scala
val wiki: RDD[WikiArticle] = ...
```


wiki

```scala
wiki.map {
    article => article.text.toLowerCase
}
```