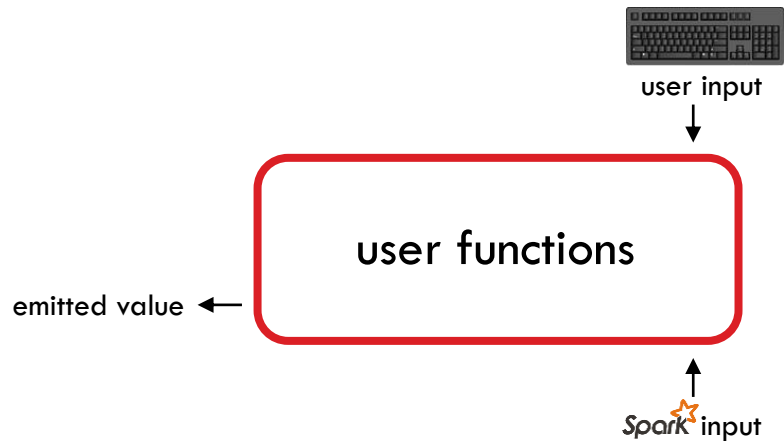
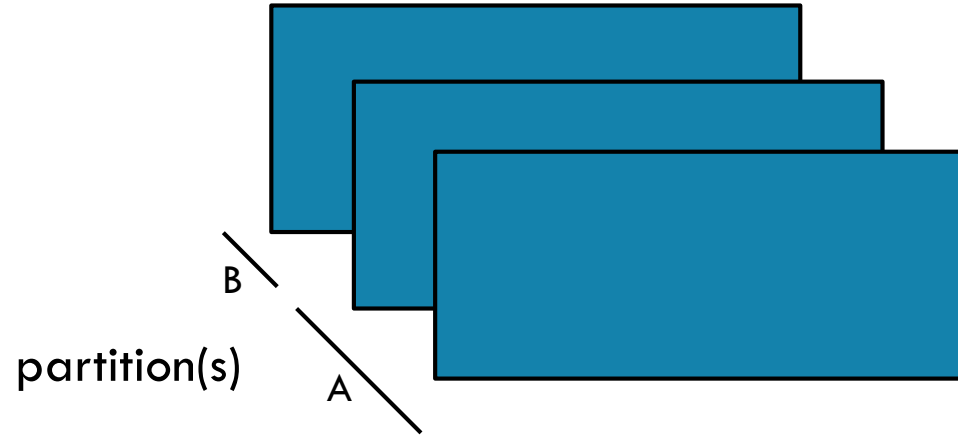


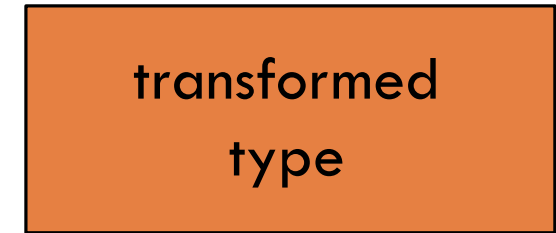
## RDD



Legend

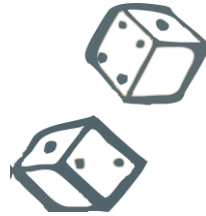


## RDD Elements

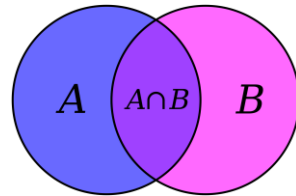




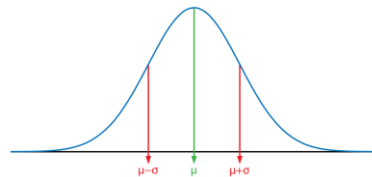
Legend



Randomized operation



Set Theory / Relational operation



Numeric calculation

*Spark*  Operations =


  
TRANSFORMATIONS

+



ACTIONS

 = easy

 = medium

# Essential Core & Intermediate Spark Operations

## TRANSFORMATIONS

### General

- map
- filter
- flatMap
- mapPartitions
- mapPartitionsWithIndex
- groupBy
- sortBy

### Math / Statistical

- sample
- randomSplit

### Set Theory / Relational

- union
- intersection
- subtract
- distinct
- cartesian
- zip

### Data Structure / I/O

- keyBy
- zipWithIndex
- zipWithUniqueId
- zipPartitions
- coalesce
- repartition
- repartitionAndSortWithinPartitions
- pipe

## ACTIONS

- reduce
- collect
- aggregate
- fold
- first
- take
- foreach
- top
- treeAggregate
- treeReduce
- foreachPartition
- collectAsMap


- count
- takeSample
- max
- min
- sum
- histogram
- mean
- variance
- stdev
- sampleVariance
- countApprox
- countApproxDistinct

- takeOrdered

- saveAsTextFile
- saveAsSequenceFile
- saveAsObjectFile
- saveAsHadoopDataset
- saveAsHadoopFile
- saveAsNewAPIHadoopDataset
- saveAsNewAPIHadoopFile



 = easy

 = medium

# Essential Core & Intermediate PairRDD Operations

TRANSFORMATIONS

## General

- flatMapValues
- groupByKey
- reduceByKey
- reduceByKeyLocally
- foldByKey
- aggregateByKey
- sortByKey
- combineByKey

## Math / Statistical

- sampleByKey

## Set Theory / Relational

- cogroup (=groupWith)
- join
- subtractByKey
- fullOuterJoin
- leftOuterJoin
- rightOuterJoin

## Data Structure

- partitionBy

ACTIONS

- keys
- values

- countByKey
- countByValue
- countByValueApprox
- countApproxDistinctByKey
- countApproxDistinctByKey
- countByKeyApprox
- sampleByKeyExact





vs

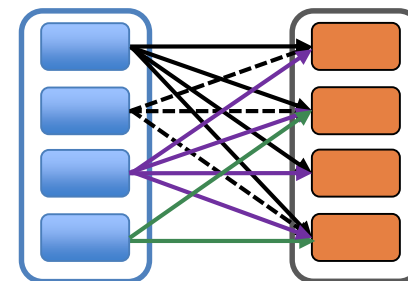
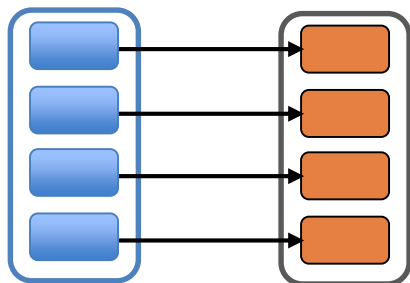


narrow

wide

*each partition of the parent RDD is used by  
at most one partition of the child RDD*

*multiple child RDD partitions may depend  
on a single parent RDD partition*



# LINEAGE

“One of the challenges in providing RDDs as an abstraction is choosing a representation for them that can track lineage across a wide range of transformations.”

“The most interesting question in designing this interface is how to represent dependencies between RDDs.”

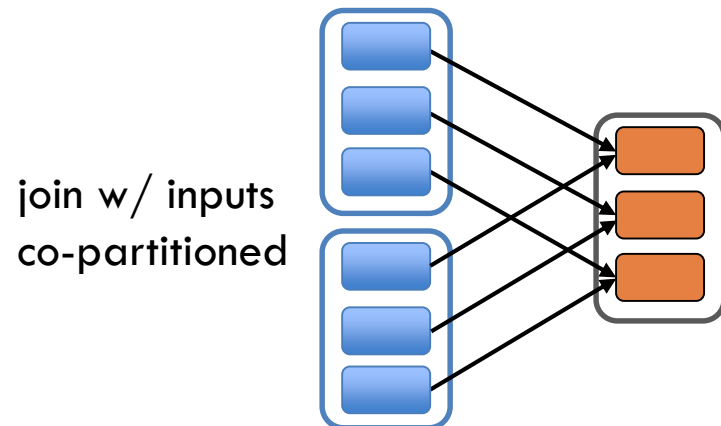
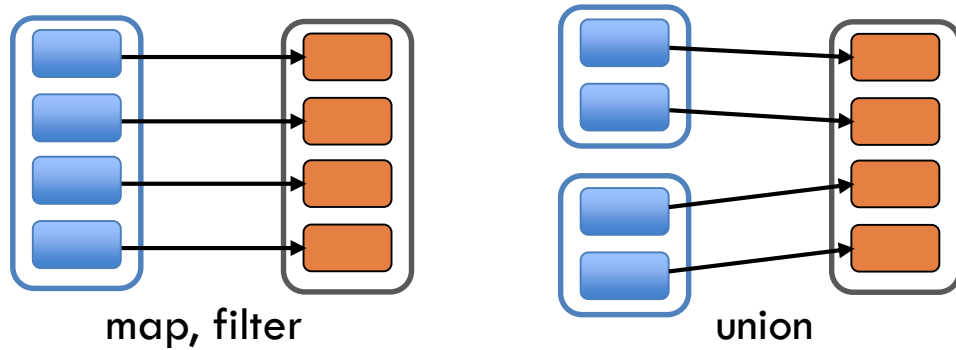
“We found it both sufficient and useful to classify dependencies into two types:

- **narrow dependencies**, where each partition of the parent RDD is used by at most one partition of the child RDD
- **wide dependencies**, where multiple child partitions may depend on it.”



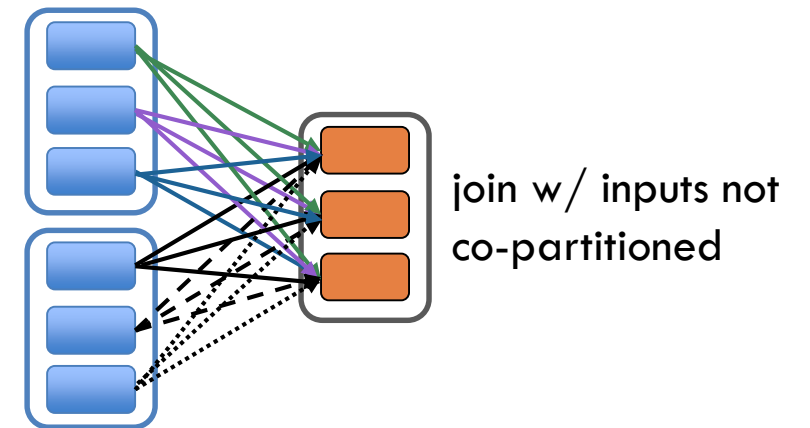
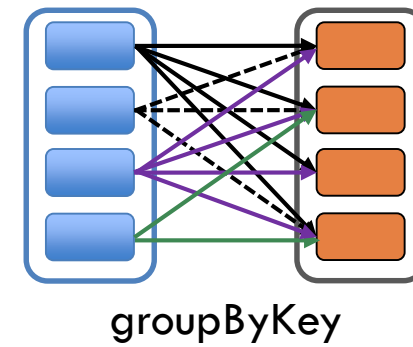
## narrow

*each partition of the parent RDD is used by at most one partition of the child RDD*

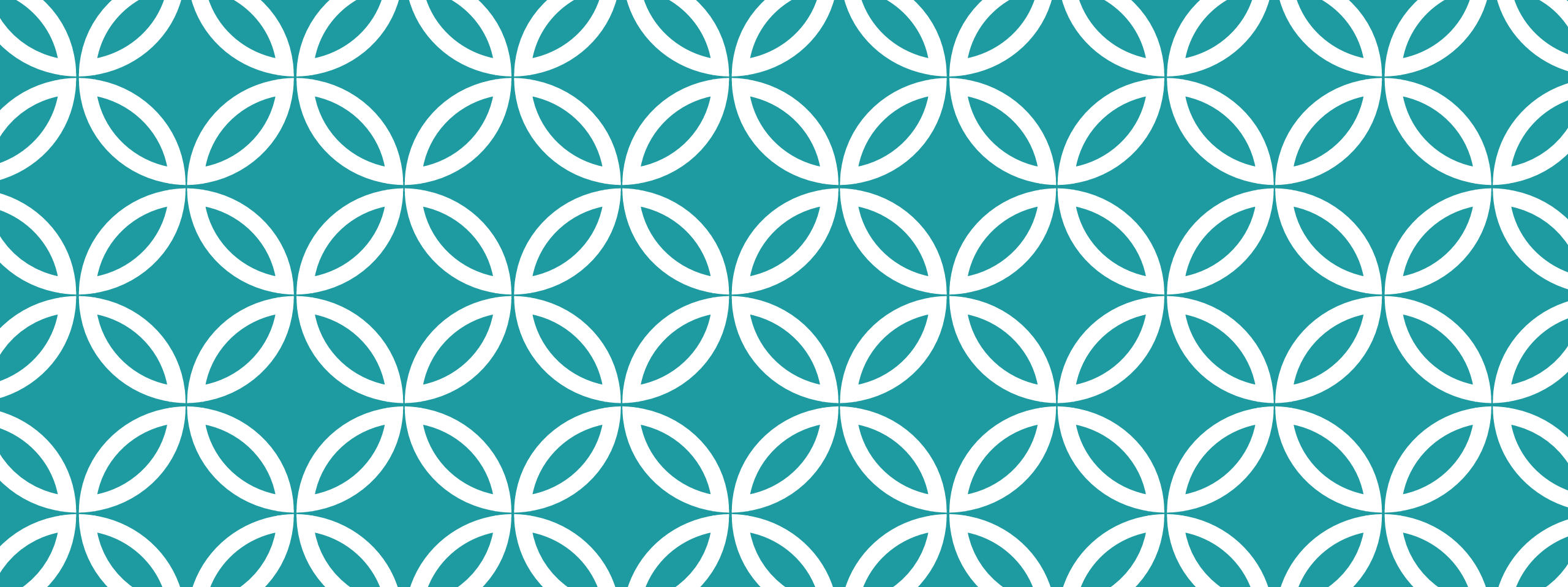


## wide

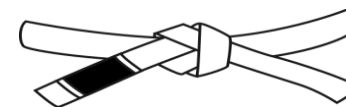
*multiple child RDD partitions may depend on a single parent RDD partition*







# TRANSFORMATIONS



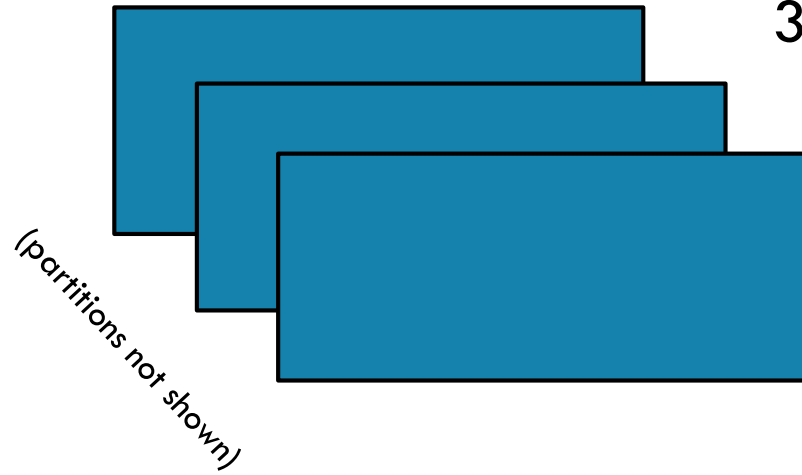
Core Operations



# MAP

RDD: x

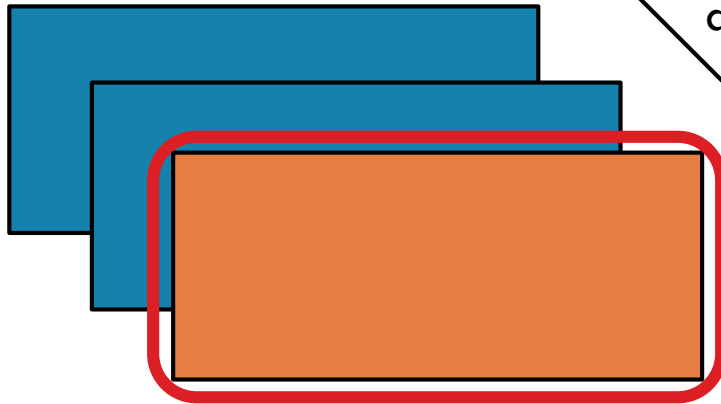
3 items in RDD





# MAP

RDD: **x**



User function  
applied item by item

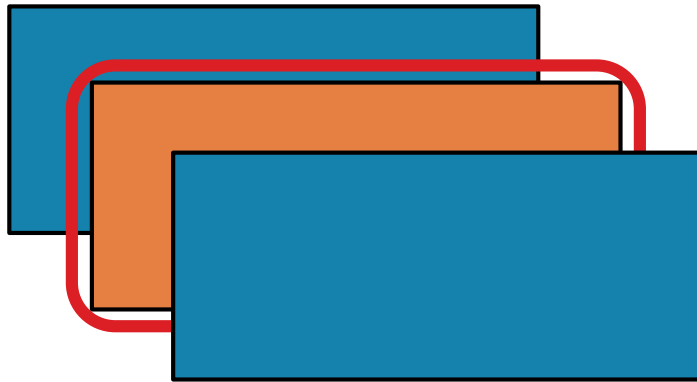
RDD: **y**





# MAP

RDD: **x**



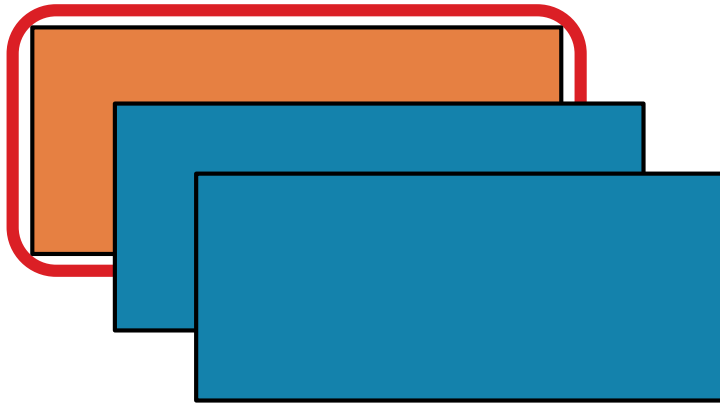
RDD: **y**



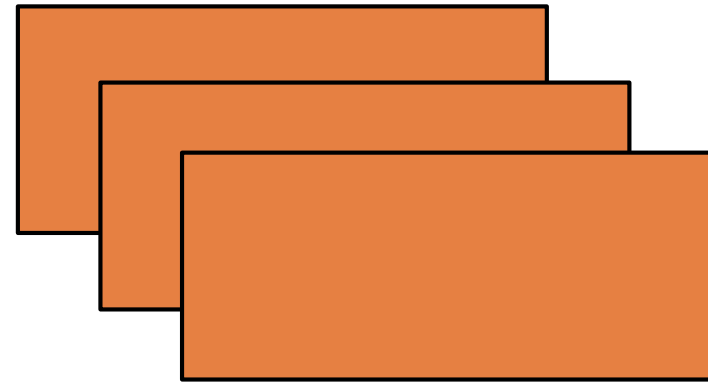


# MAP

RDD: **x**



RDD: **y**





# MAP

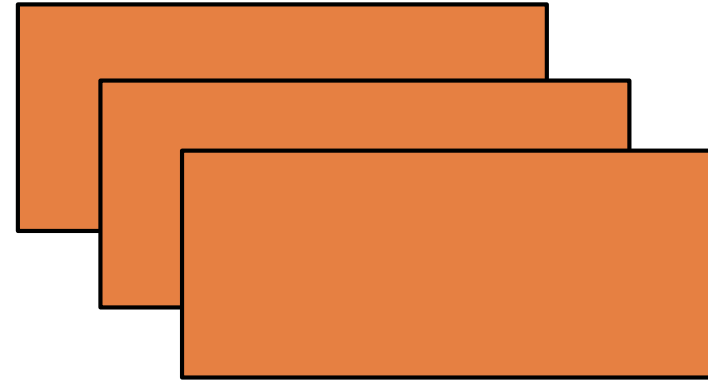
After map() has been applied...

RDD: **x**



before

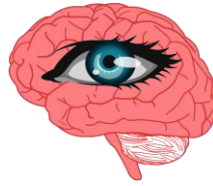
RDD: **y**



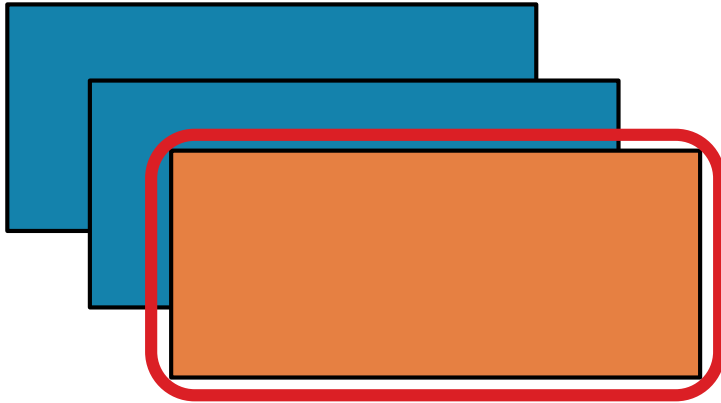
after



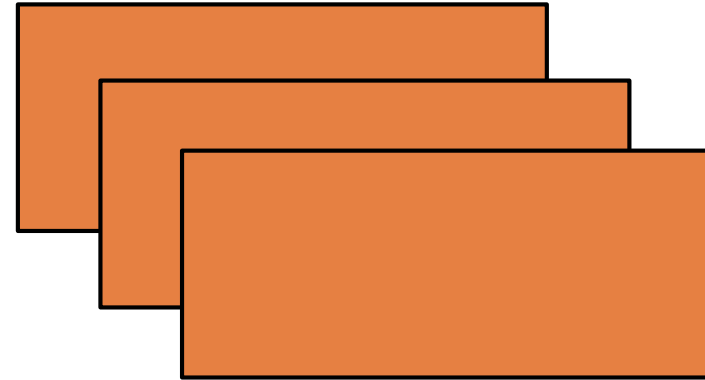
# MAP



RDD: **x**



RDD: **y**

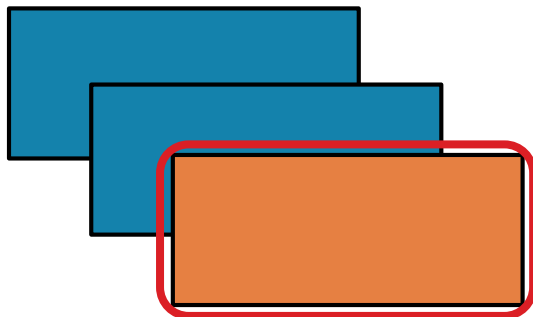


Return a new RDD by applying a function to each element of this RDD.

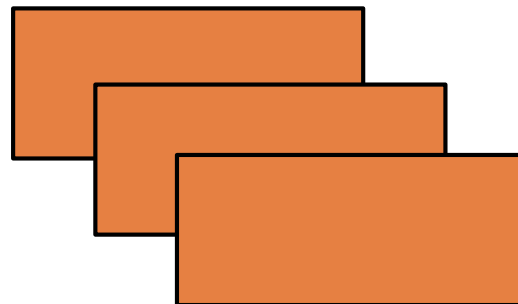


# MAP

RDD: **x**



RDD: **y**



`map(f, preservesPartitioning=False)`

Return a new RDD by applying a function to each element of this RDD



```
x = sc.parallelize(["b", "a", "c"])
y = x.map(lambda z: (z, 1))
print(x.collect())
print(y.collect())
```



**x:** ['b', 'a', 'c']

**y:** [('b', 1), ('a', 1), ('c', 1)]



```
val x = sc.parallelize(Array("b", "a", "c"))
val y = x.map(z => (z,1))
println(x.collect().mkString(", "))
println(y.collect().mkString(", "))
```



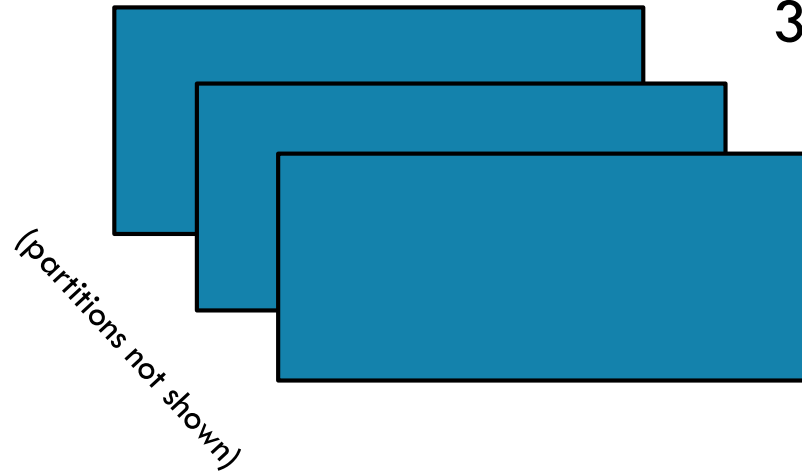




# FILTER

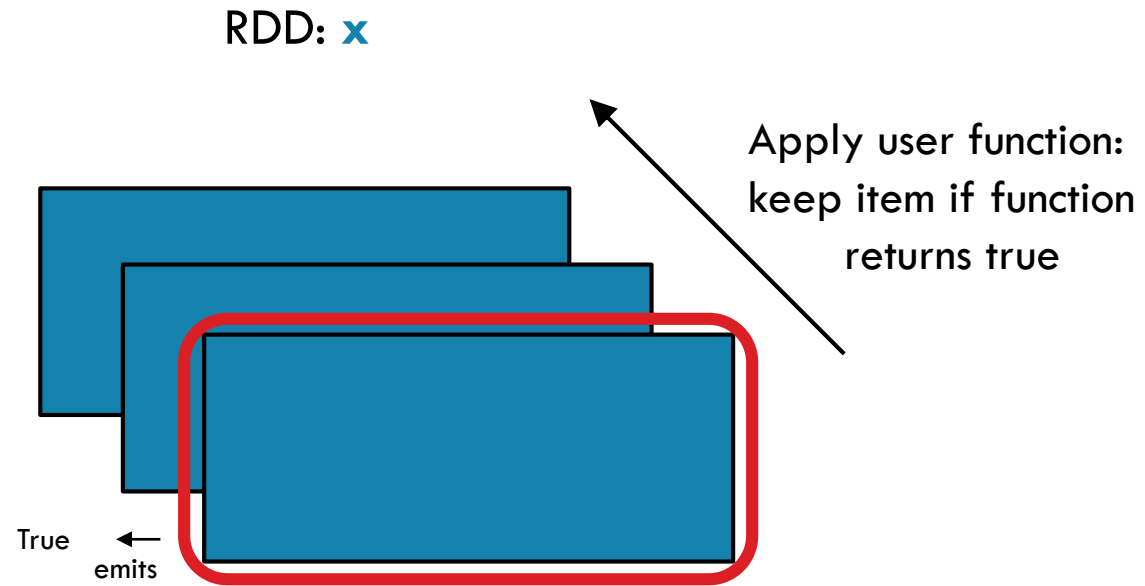
RDD: x

3 items in RDD





# FILTER



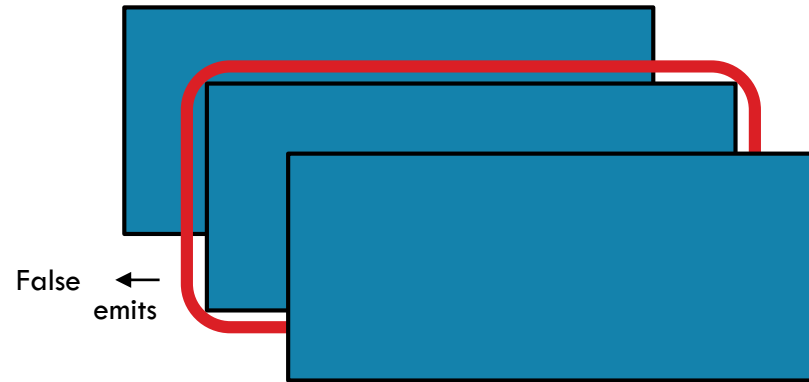
RDD: **y**



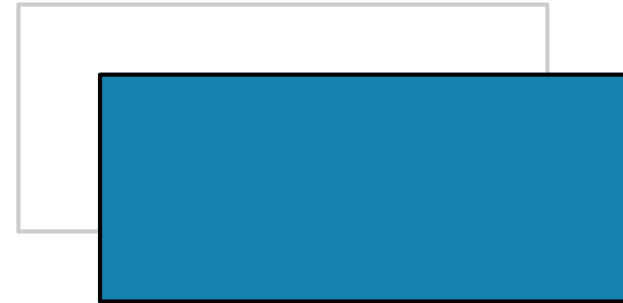


# FILTER

RDD: **x**



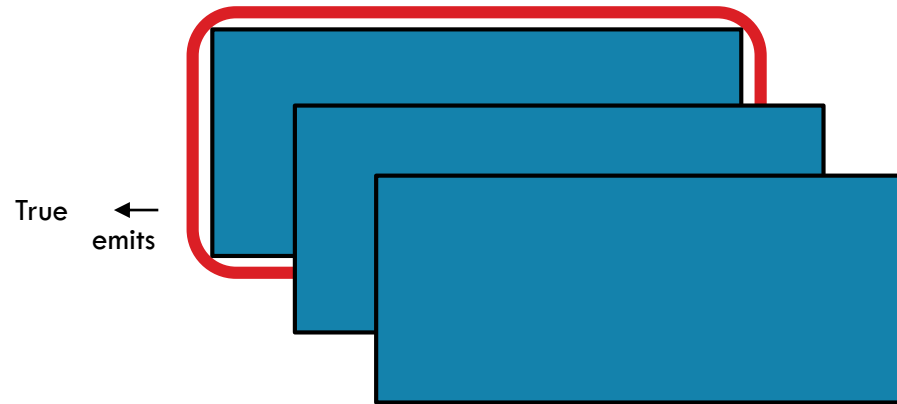
RDD: **y**



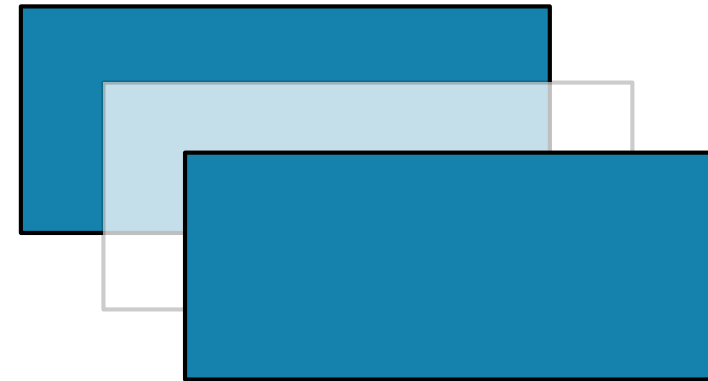


# FILTER

RDD: **x**



RDD: **y**





After `filter()` has been applied...

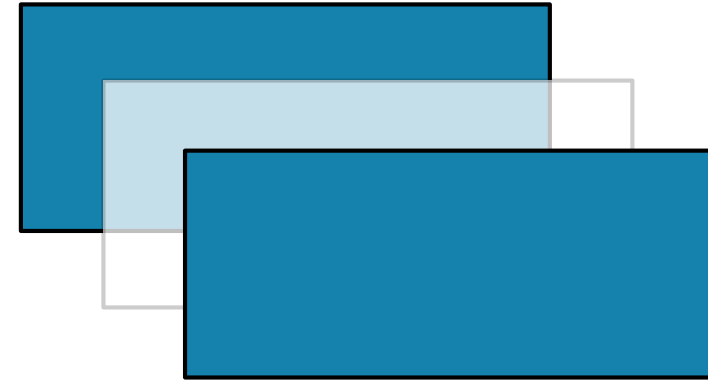
# FILTER

RDD: **x**



before

RDD: **y**

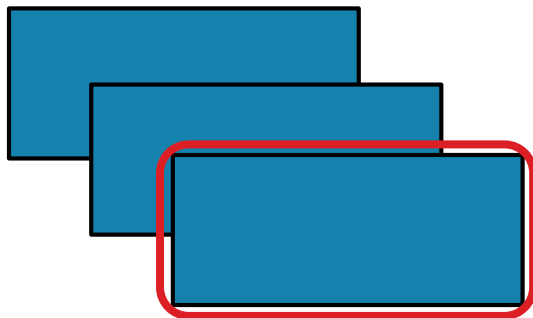


after



# FILTER

RDD: **x**



RDD: **y**



`filter(f)`

Return a new RDD containing only the elements that satisfy a predicate



```
x = sc.parallelize([1,2,3])
y = x.filter(lambda x: x%2 == 1) #keep odd values
print(x.collect())
print(y.collect())
```



**x:** [1, 2, 3]

**y:** [1, 3]



```
val x = sc.parallelize(Array(1,2,3))
val y = x.filter(n => n%2 == 1)
println(x.collect().mkString(", "))
println(y.collect().mkString(", "))
```

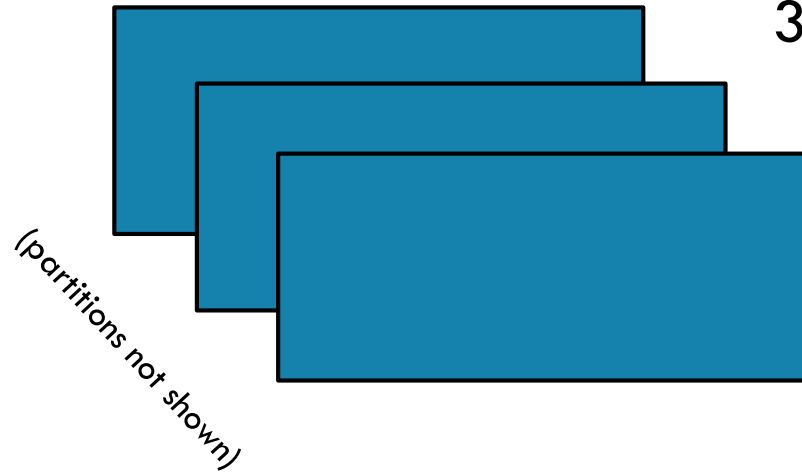




# FLATMAP

RDD: x

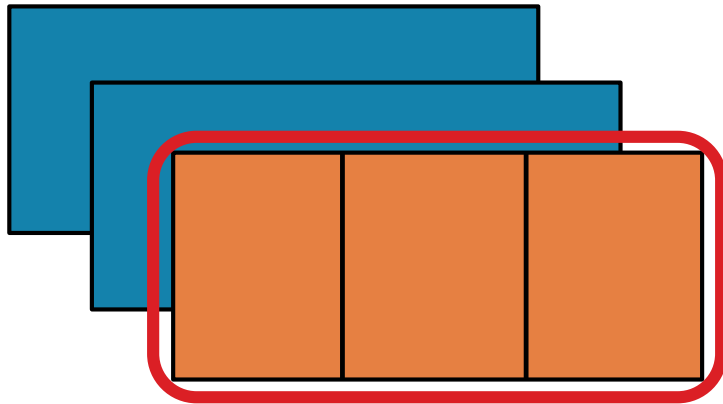
3 items in RDD



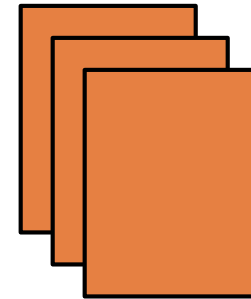


# FLATMAP

RDD: **x**



RDD: **y**

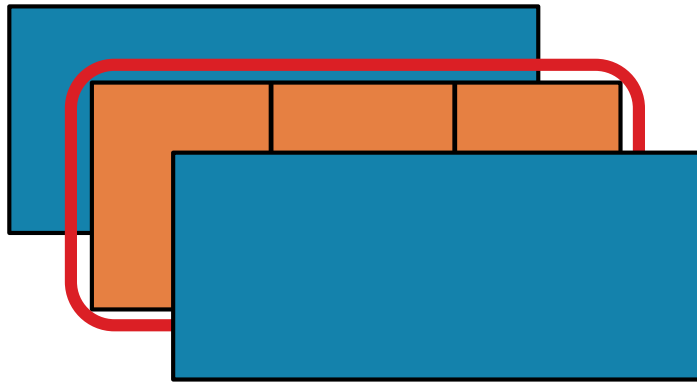




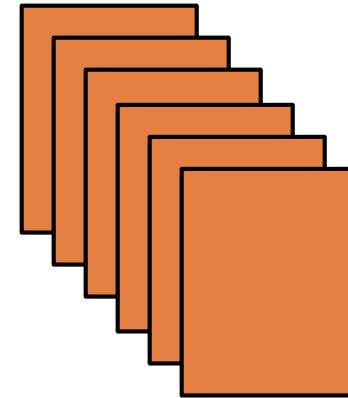


# FLATMAP

RDD: **x**



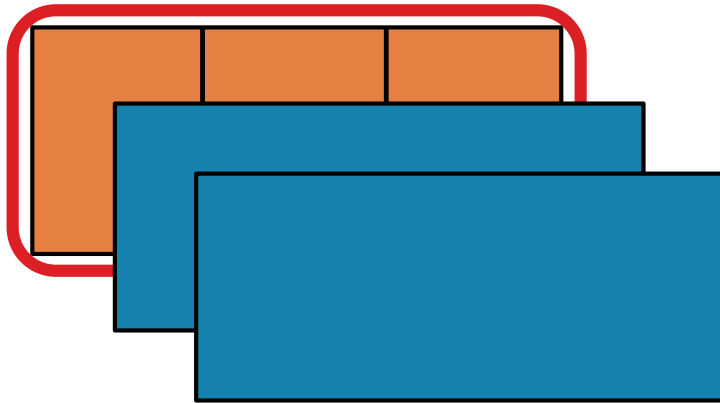
RDD: **y**





# FLATMAP

RDD: **x**



RDD: **y**

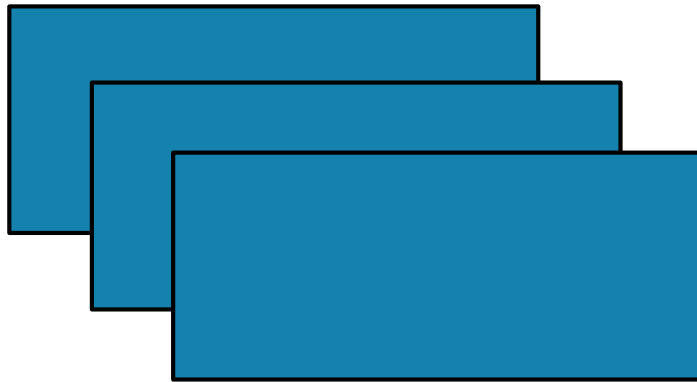




After flatmap() has been applied...

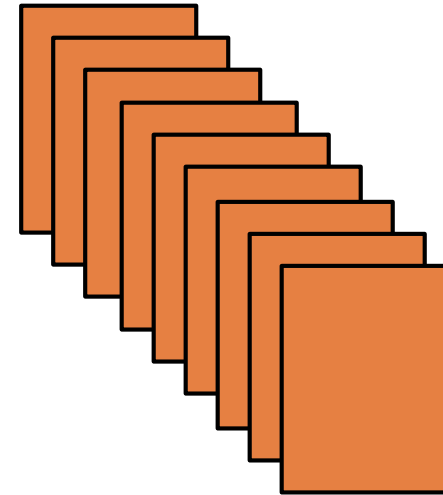
# FLATMAP

RDD: **x**



before

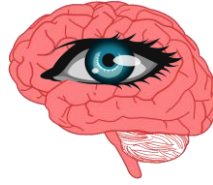
RDD: **y**



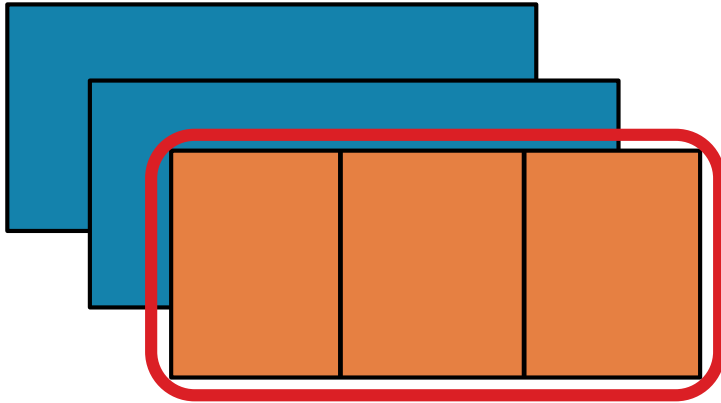
after



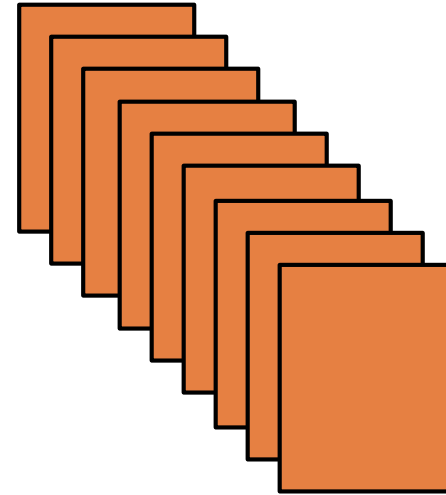
# FLATMAP



RDD: **x**



RDD: **y**

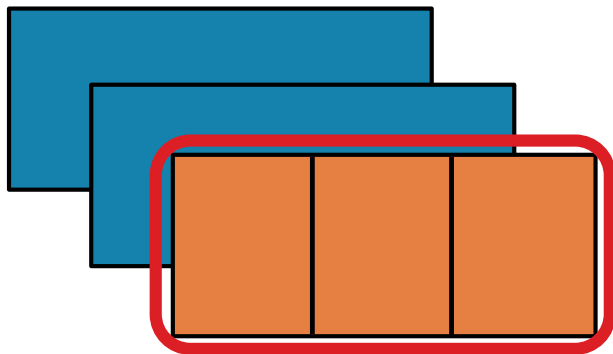


Return a new RDD by first applying a function to all elements of this RDD, and then flattening the results



# FLATMAP

RDD: **x**



RDD: **y**



`flatMap(f, preservesPartitioning=False)`

Return a new RDD by first applying a function to all elements of this RDD, and then flattening the results



```
x = sc.parallelize([1,2,3])
y = x.flatMap(lambda x: (x, x*100, 42))
print(x.collect())
print(y.collect())
```



**x:** [1, 2, 3]

**y:** [1, 100, 42, 2, 200, 42, 3, 300, 42]



```
val x = sc.parallelize(Array(1,2,3))
val y = x.flatMap(n => Array(n, n*100, 42))
println(x.collect().mkString(", "))
println(y.collect().mkString(", "))
```





# GROUPBY

RDD: x

4 items in RDD

James

Anna

Fred

John

(partitions not shown)

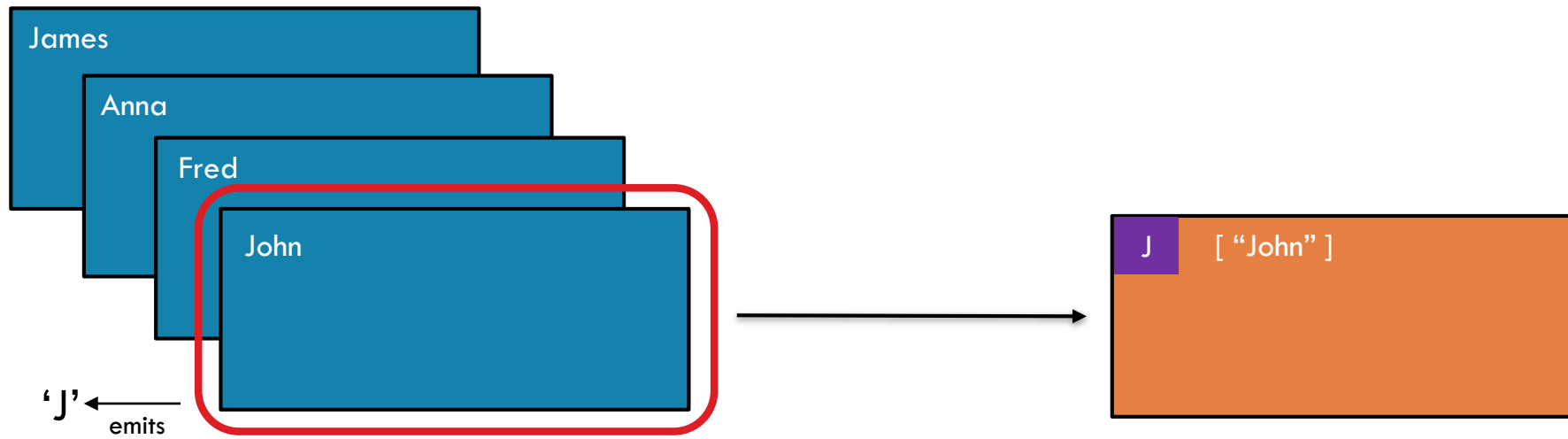




# GROUPBY

RDD: **x**

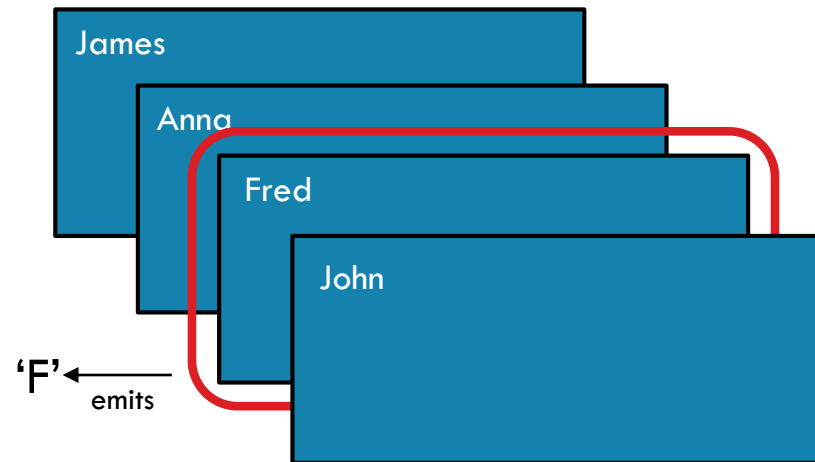
RDD: **y**



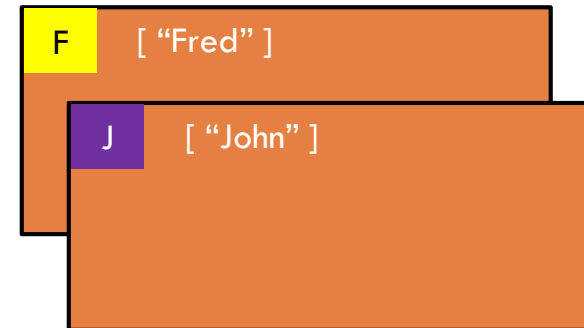


# GROUPBY

RDD: **x**



RDD: **y**

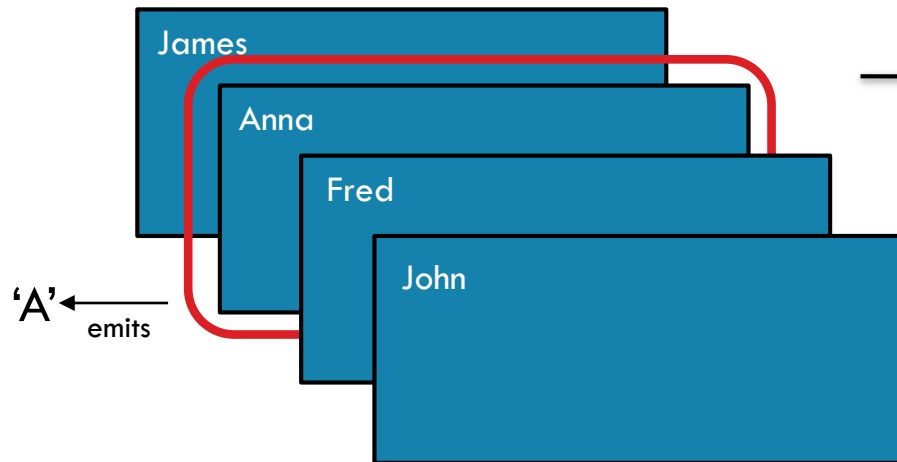




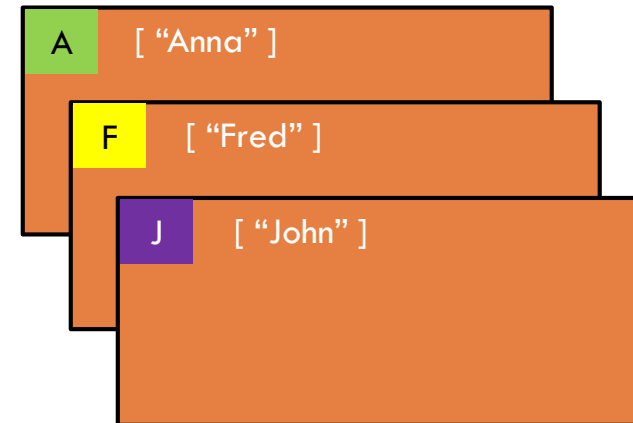


# GROUPBY

RDD: **x**



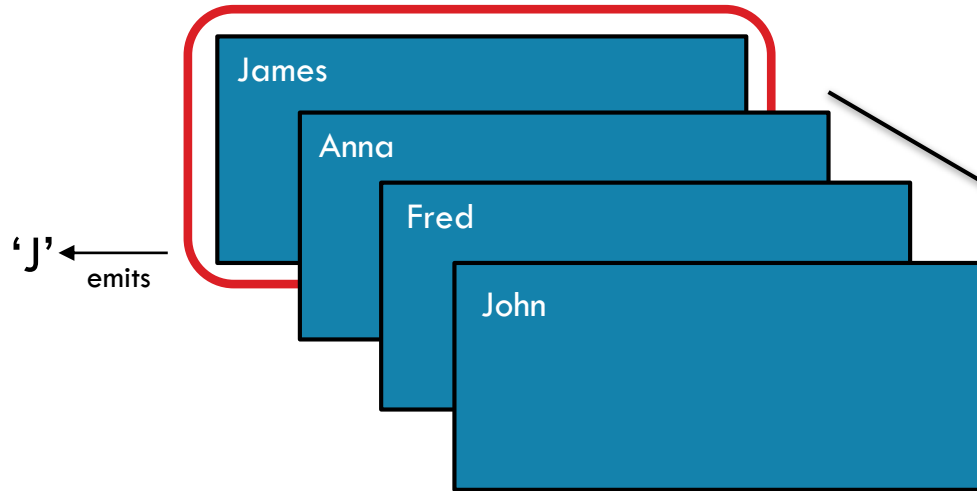
RDD: **y**



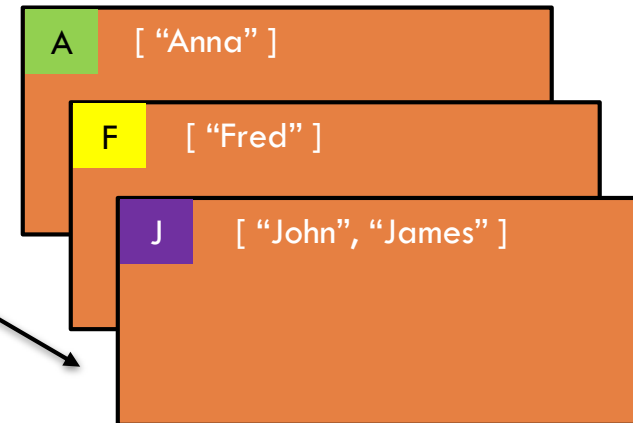


# GROUPBY

RDD: **x**

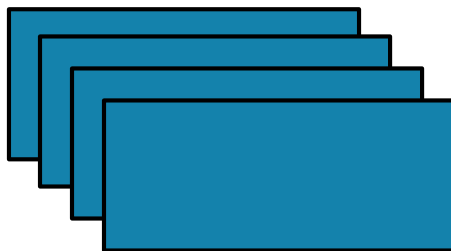


RDD: **y**

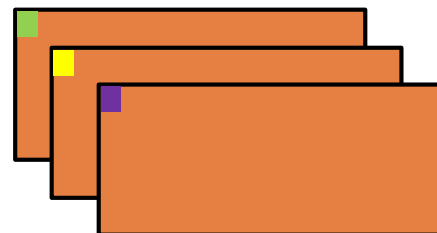


# GROUPBY

RDD: **x**



RDD: **y**



`groupBy(f, numPartitions=None)`

Group the data in the original RDD. Create pairs where the key is the output of a user function, and the value is all items for which the function yields this key.



```
x = sc.parallelize(['John', 'Fred', 'Anna', 'James'])  
y = x.groupBy(lambda w: w[0])  
print [(k, list(v)) for (k, v) in y.collect()]
```



**x**: ['John', 'Fred', 'Anna', 'James']

**y**: [('A', ['Anna']), ('J', ['John', 'James']), ('F', ['Fred'])]



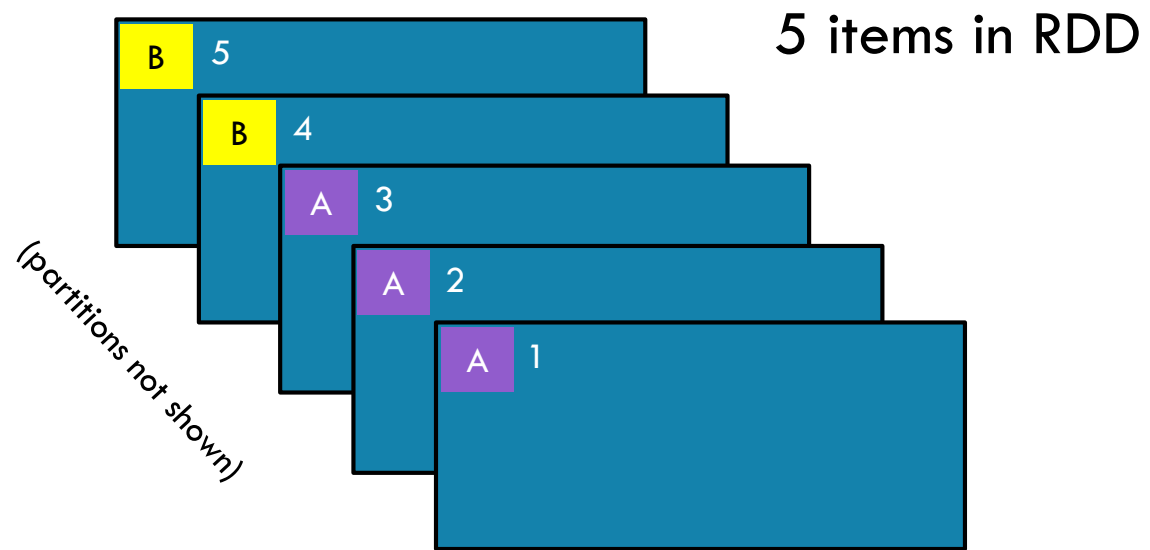
```
val x = sc.parallelize(  
    Array("John", "Fred", "Anna", "James"))  
val y = x.groupBy(w => w.charAt(0))  
println(y.collect().mkString(", "))
```





# GROUPBYKEY

Pair RDD: x

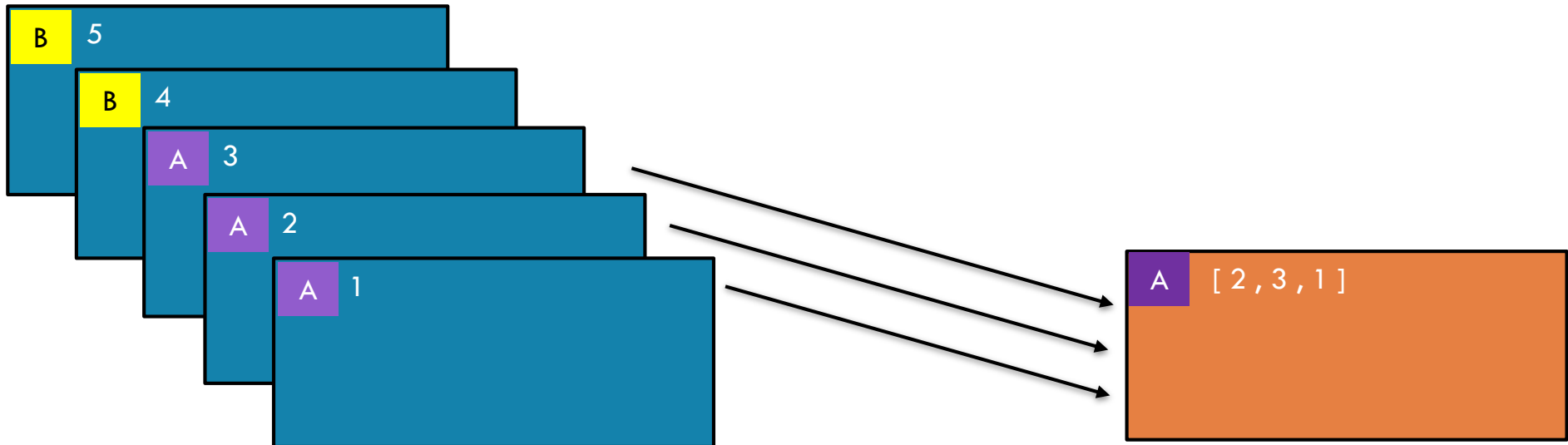




# GROUPBYKEY

Pair RDD: **x**

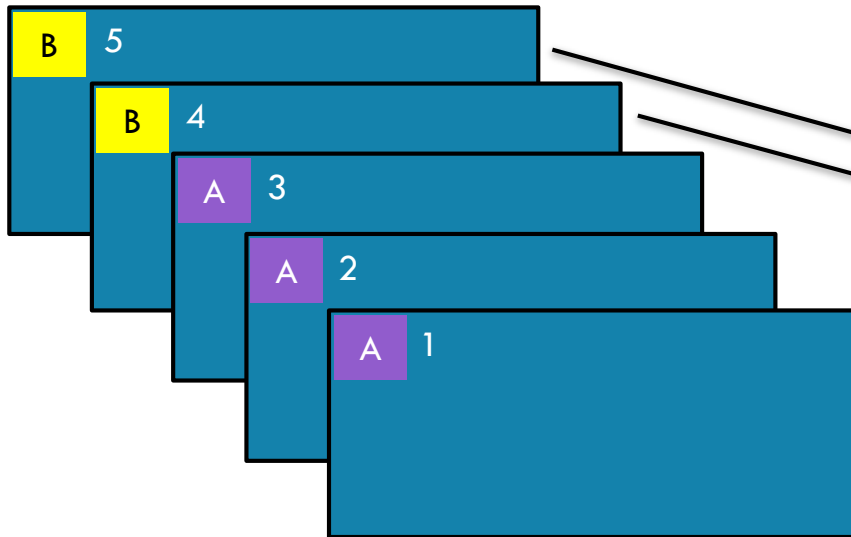
RDD: **y**



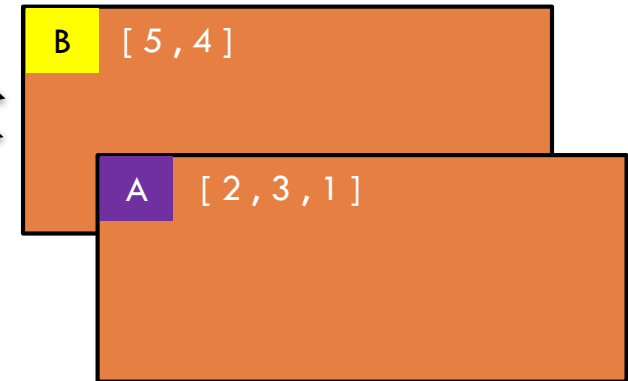


# GROUPBYKEY

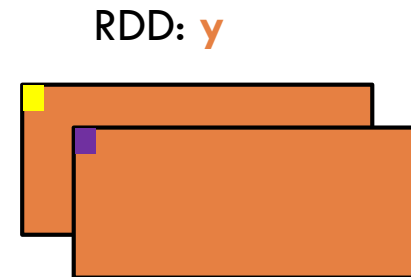
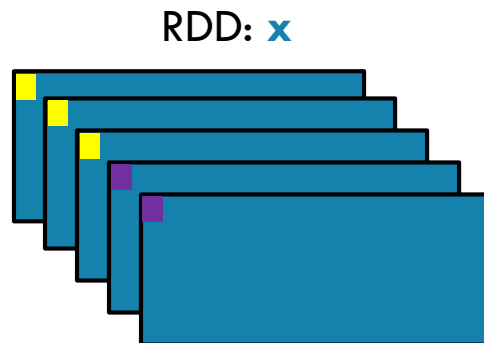
Pair RDD: **x**



RDD: **y**



# GROUPBYKEY



`groupByKey(numPartitions=None)`

Group the values for each key in the original RDD. Create a new pair where the original key corresponds to this collected group of values.

```
x = sc.parallelize([('B',5),('B',4),('A',3),('A',2),('A',1)])
y = x.groupByKey()
print(x.collect())
print(list((j[0], list(j[1])) for j in y.collect()))
```



**x:** [('B', 5), ('B', 4), ('A', 3), ('A', 2), ('A', 1)]

**y:** [('A', [2, 3, 1]), ('B', [5, 4])]

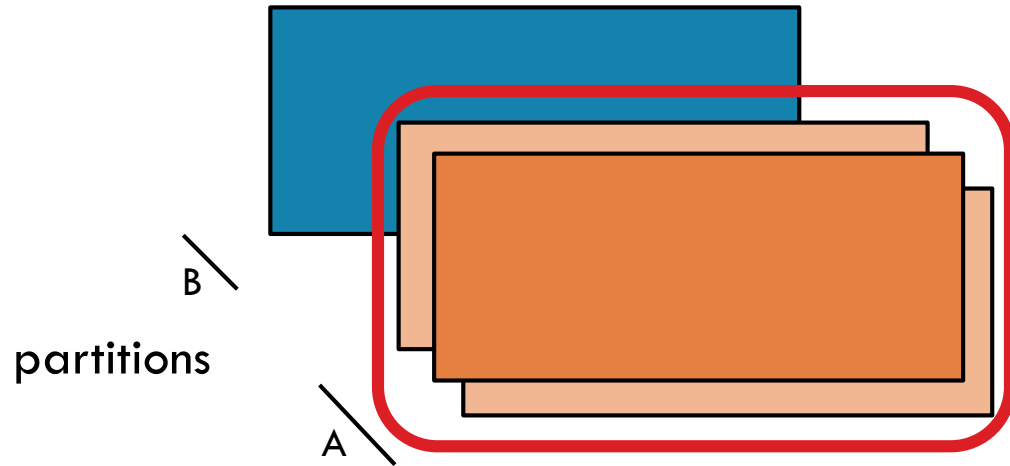
```
val x = sc.parallelize(
    Array(('B',5),('B',4),('A',3),('A',2),('A',1)))
val y = x.groupByKey()
println(x.collect().mkString(", "))
println(y.collect().mkString(", "))
```





# MAPPARTITIONS

RDD: **x**



RDD: **y**





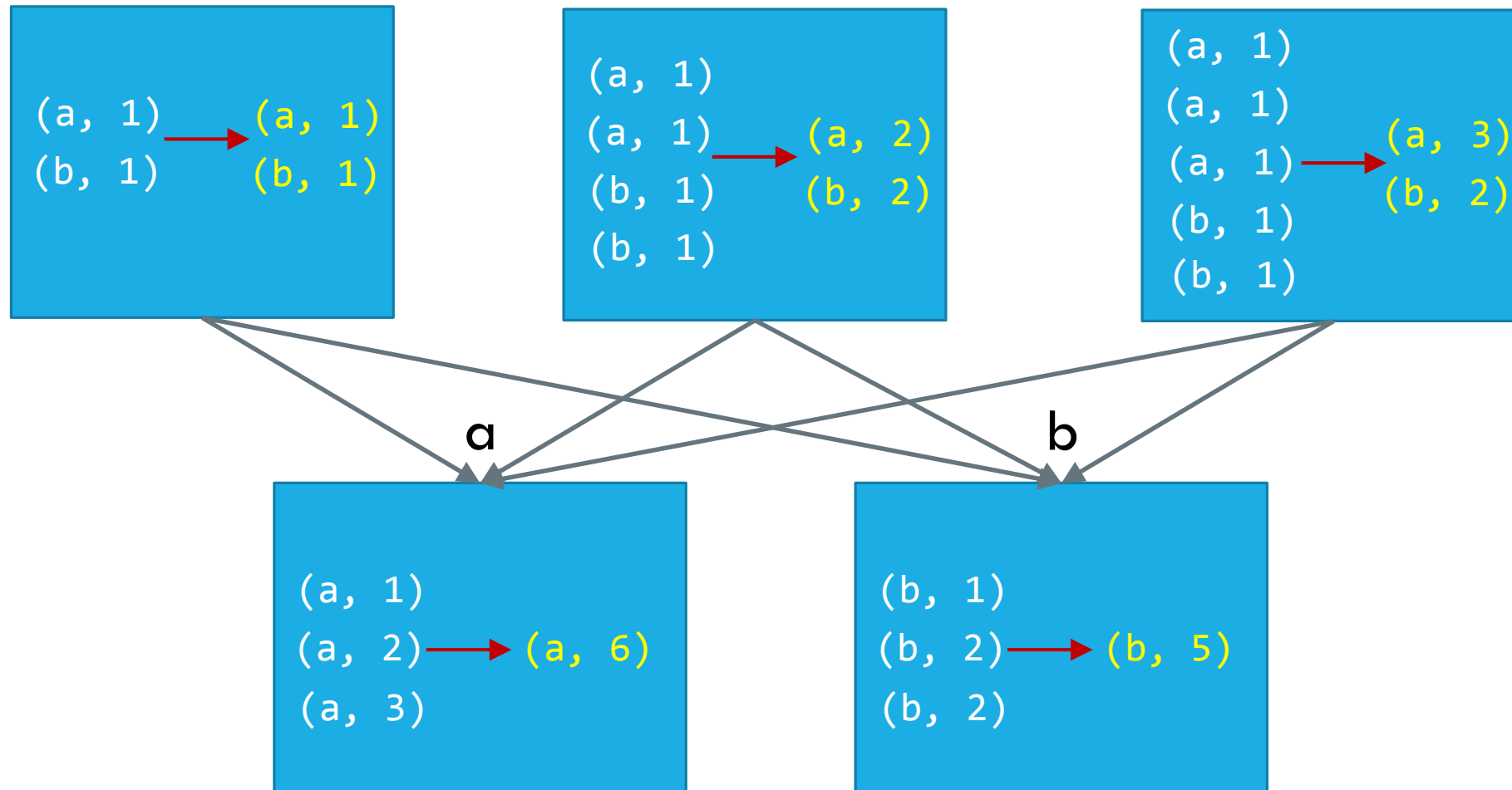
# REDUCEBYKEY vs GROUPBYKEY

```
val words = Array("one", "two", "two", "three", "three", "three")  
val wordPairsRDD = sc.parallelize(words).map(word => (word, 1))
```

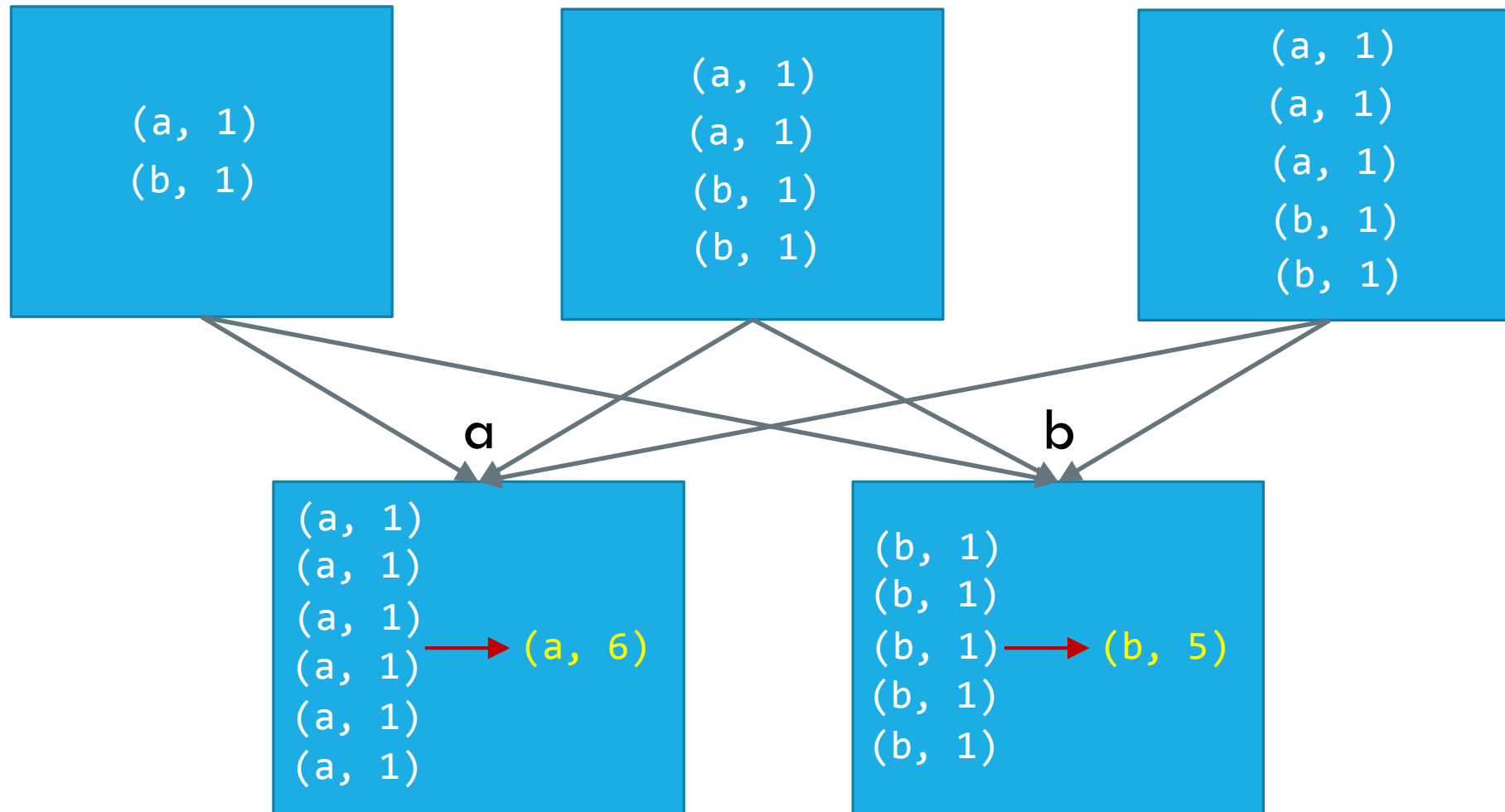
```
val wordCountsWithReduce = wordPairsRDD  
  .reduceByKey(_ + _)  
  .collect()
```

```
val wordCountsWithGroup = wordPairsRDD  
  .groupByKey()  
  .map(t => (t._1, t._2.sum))  
  .collect()
```

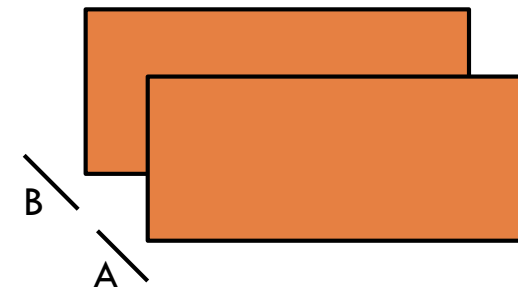
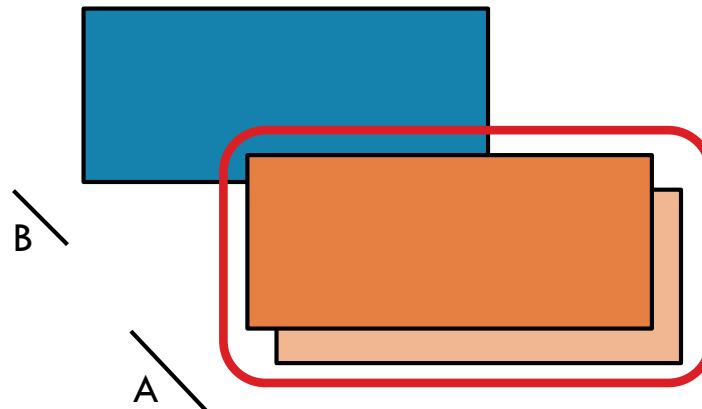
# REDUCEBYKEY



# GROUPBYKEY



# MAPPARTITIONS



`mapPartitions(f, preservesPartitioning=False)`

Return a new RDD by applying a function to each partition of this RDD



```
x = sc.parallelize([1,2,3], 2)
```

```
def f(iterator): yield sum(iterator); yield 42
```

```
y = x.mapPartitions(f)
```

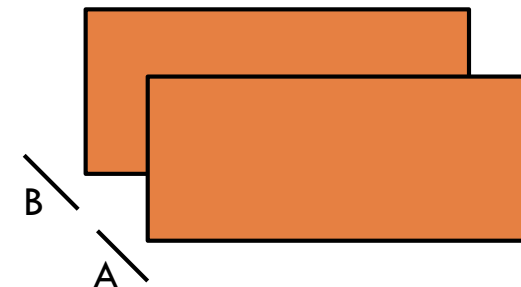
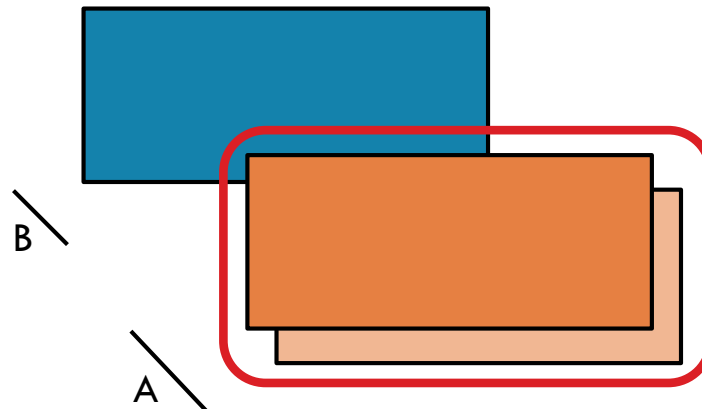
```
# glom() flattens elements on the same partition
print(x.glom().collect())
print(y.glom().collect())
```

**x:** `[[1], [2, 3]]`

**y:** `[[1, 42], [5, 42]]`



# MAPPARTITIONS



`mapPartitions(f, preservesPartitioning=False)`

Return a new RDD by applying a function to each partition of this RDD



```
val x = sc.parallelize(Array(1,2,3), 2)
```

```
def f(i:Iterator[Int])={ (i.sum,42).productIterator }
```

```
val y = x.mapPartitions(f)
```

```
// glom() flattens elements on the same partition
```

```
val xOut = x.glom().collect()
```

```
val yOut = y.glom().collect()
```

**x:** Array(Array(1), Array(2, 3))

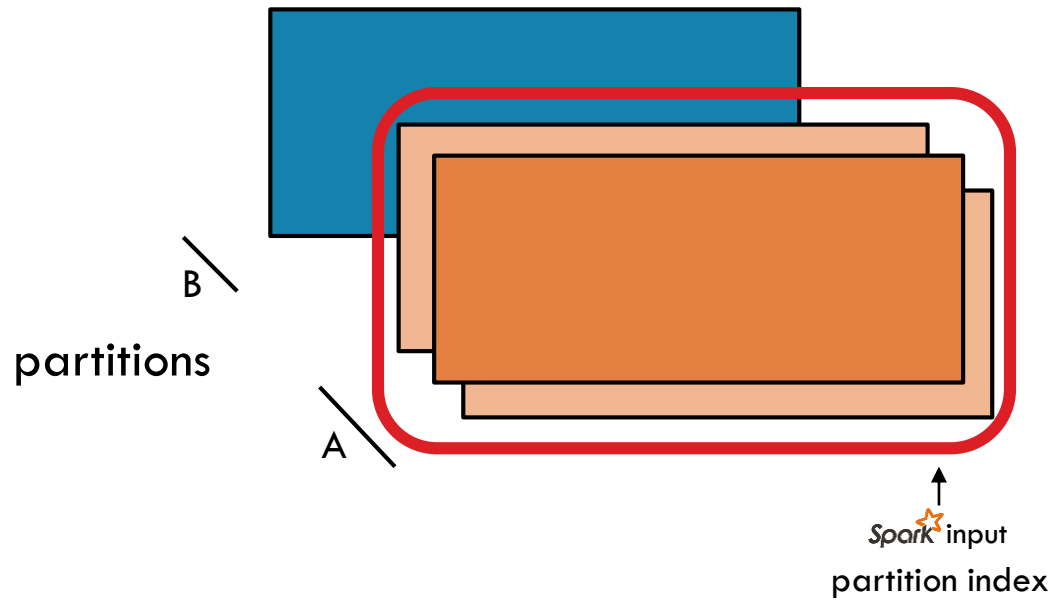
**y:** Array(Array(1, 42), Array(5, 42))





# MAPPARTITIONSWITHINDEX

RDD: **x**

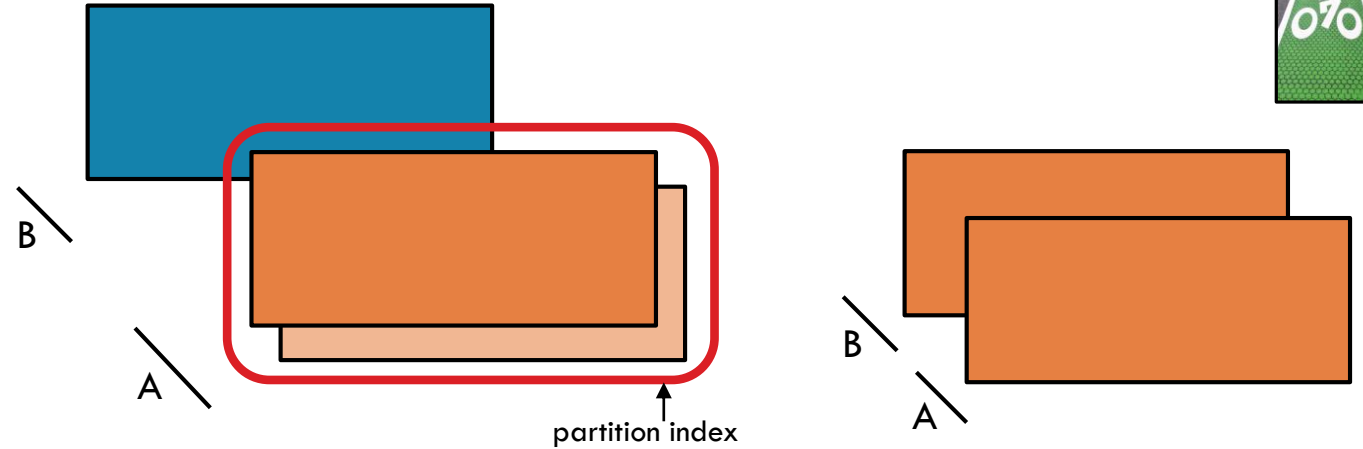


RDD: **y**





# MAPPARTITIONSWITHINDEX



`mapPartitionsWithIndex(f, preservesPartitioning=False)`


Return a new RDD by applying a function to each partition of this RDD, while tracking the index of the original partition

```
x = sc.parallelize([1,2,3], 2)
```

```
def f(partitionIndex, iterator): yield (partitionIndex, sum(iterator))
```

```
y = x.mapPartitionsWithIndex(f)
```

```
# glom() flattens elements on the same partition  
print(x.glom().collect())  
print(y.glom().collect())
```



B      A

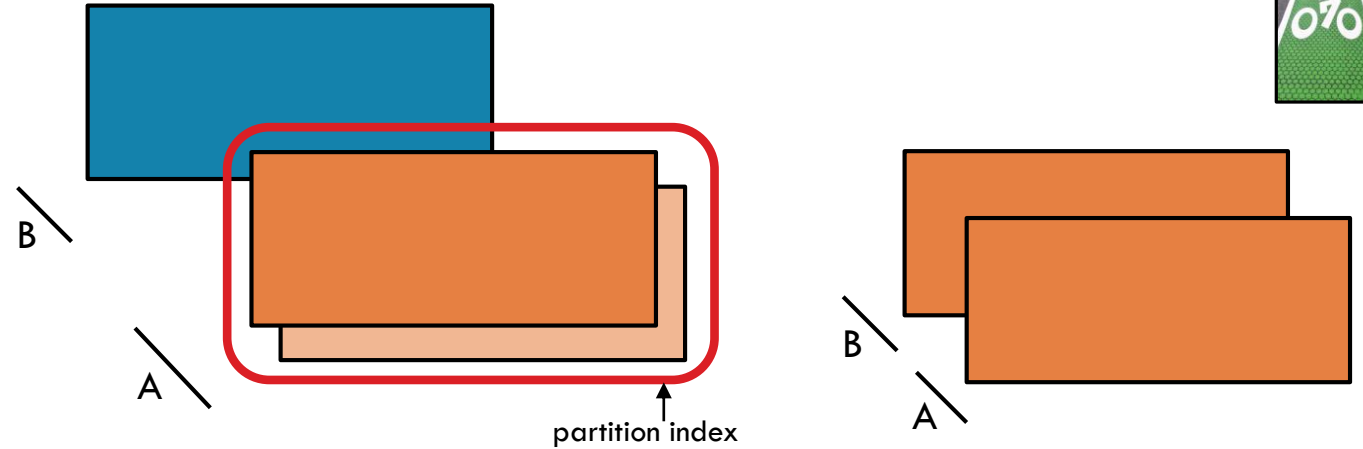
x: [[1], [2, 3]]

y: [[0, 1], [1, 5]]





# MAPPARTITIONSWITHINDEX



`mapPartitionsWithIndex(f, preservesPartitioning=False)`

Return a new RDD by applying a function to each partition of this RDD, while tracking the index of the original partition.

```
val x = sc.parallelize(Array(1,2,3), 2)
```


```
def f(partitionIndex:Int, i:Iterator[Int]) = {  
  (partitionIndex, i.sum).productIterator  
}
```

```
val y = x.mapPartitionsWithIndex(f)
```

```
// glom() flattens elements on the same partition
```

```
val xOut = x.glom().collect()
```

```
val yOut = y.glom().collect()
```



**x:** Array(Array(1), Array(2, 3))

**y:** Array(Array(0, 1), Array(1, 5))



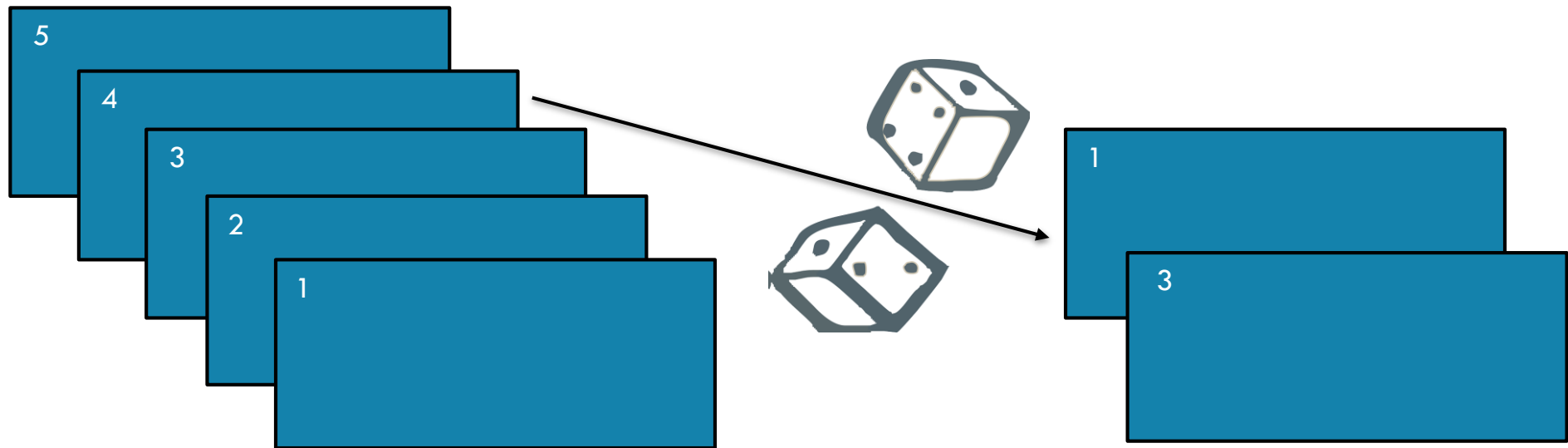




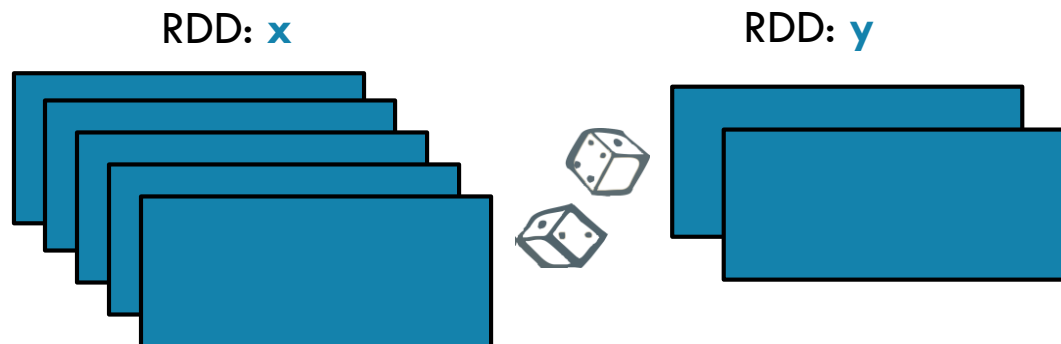
# SAMPLE

RDD: **x**

RDD: **y**



# SAMPLE



`sample(withReplacement, fraction, seed=None)`

Return a new RDD containing a statistical sample of the original RDD

```
x = sc.parallelize([1, 2, 3, 4, 5])
y = x.sample(False, 0.4, 42)
print(x.collect())
print(y.collect())
```



`x:` [1, 2, 3, 4, 5]

`y:` [1, 3]

```
val x = sc.parallelize(Array(1, 2, 3, 4, 5))
val y = x.sample(false, 0.4)
```

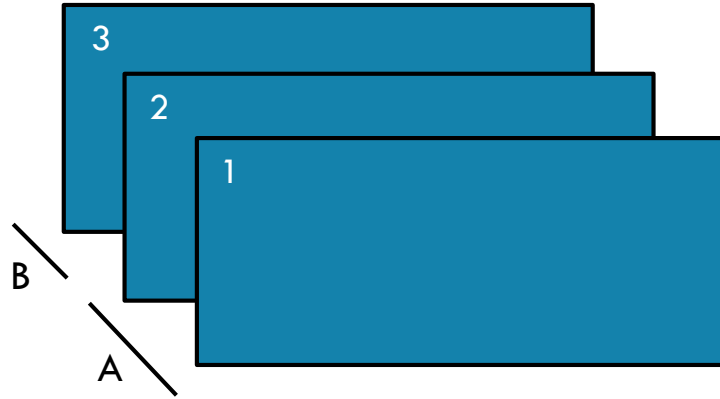
```
// omitting seed will yield different output
println(y.collect().mkString(", "))
```



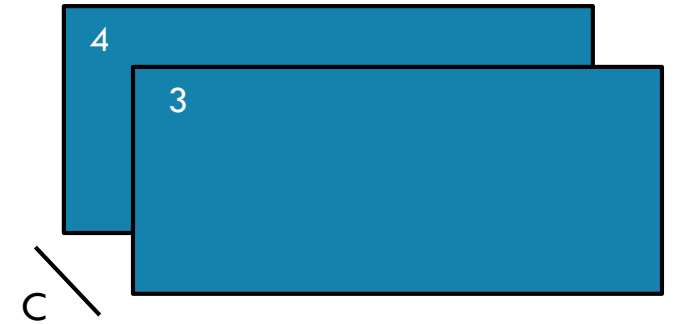


# UNION

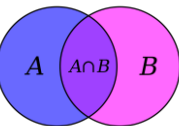
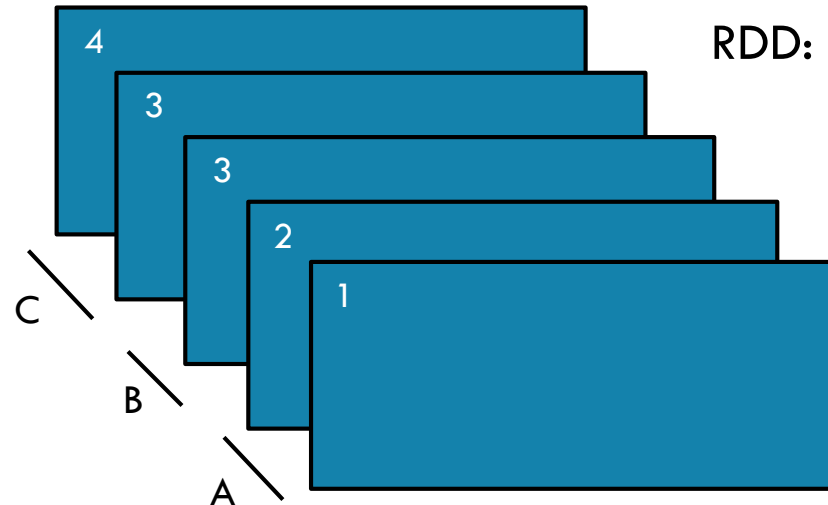
RDD: **x**



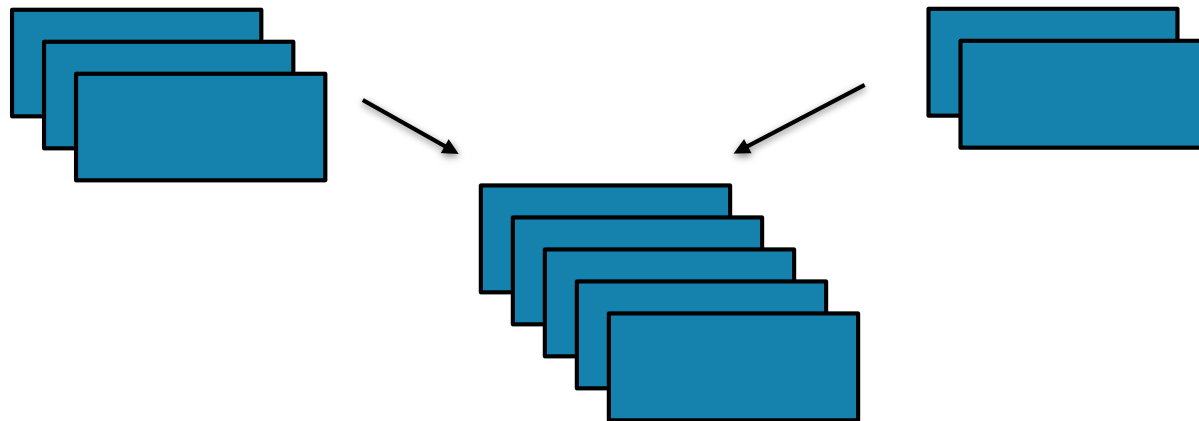
RDD: **y**



RDD: **z**



# UNION



Return a new RDD containing all items from two original RDDs. Duplicates are *not* culled.

`union(otherRDD)`



```
x = sc.parallelize([1,2,3], 2)
y = sc.parallelize([3,4], 1)
z = x.union(y)
print(z.glom().collect())
```



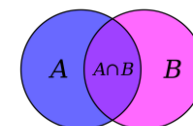
`x:` [1, 2, 3]

`y:` [3, 4]

`z:` [[1], [2, 3], [3, 4]]

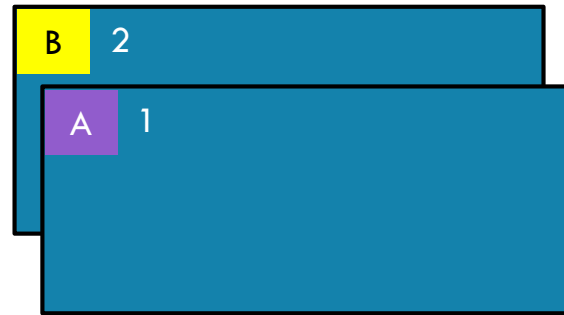


```
val x = sc.parallelize(Array(1,2,3), 2)
val y = sc.parallelize(Array(3,4), 1)
val z = x.union(y)
val zOut = z.glom().collect()
```

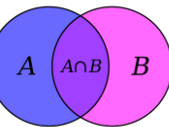


# JOIN

RDD:  $x$



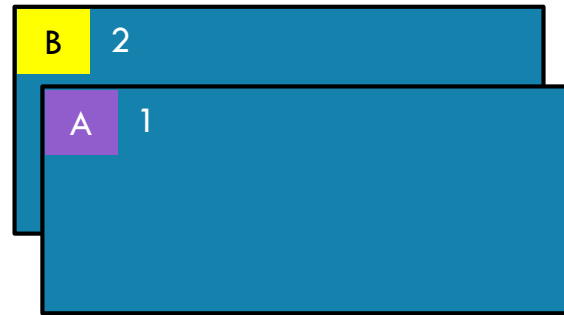
RDD:  $y$



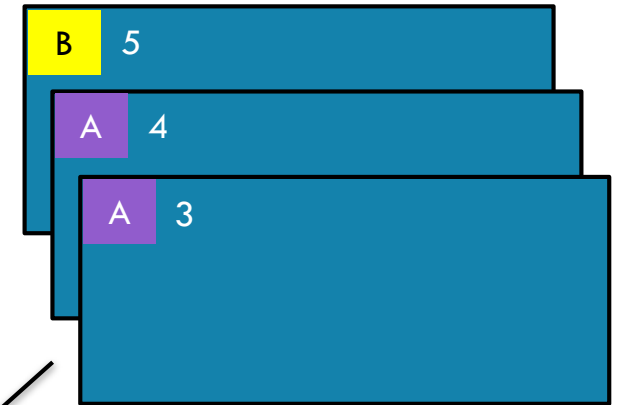


# JOIN

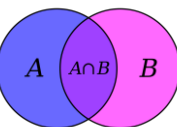
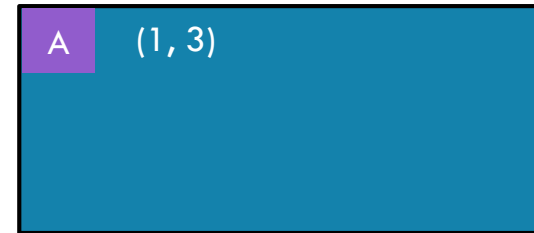
RDD: **x**



RDD: **y**



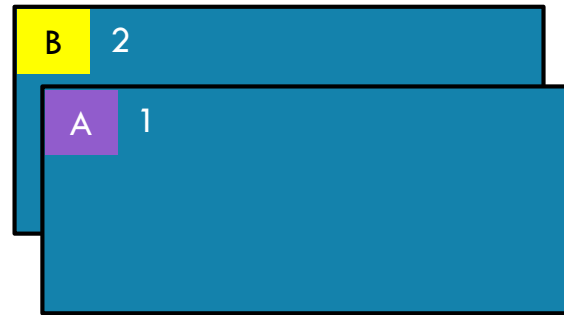
RDD: **z**





# JOIN

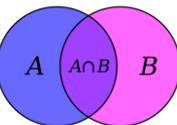
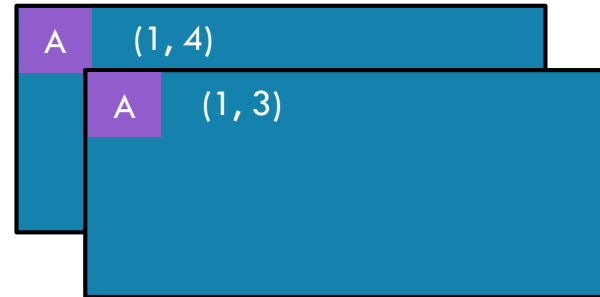
RDD: **x**



RDD: **y**



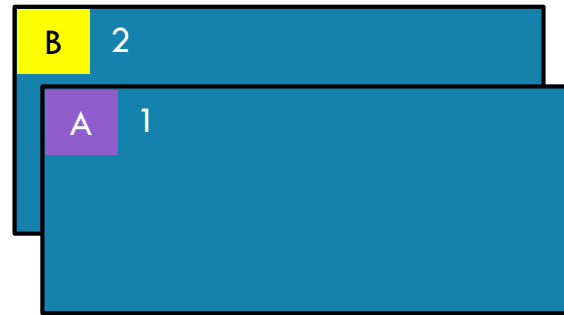
RDD: **z**



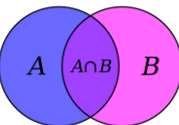
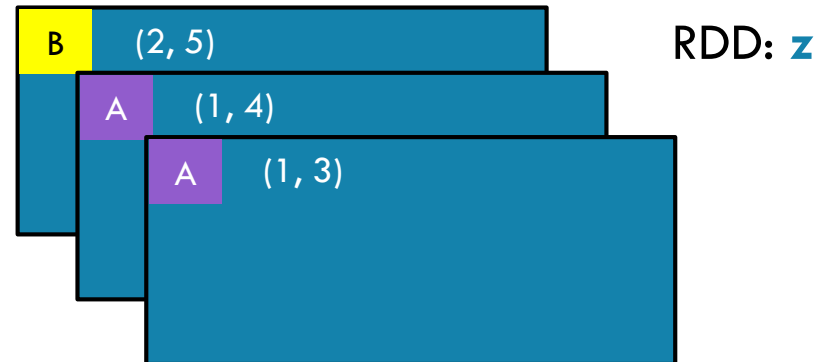


# JOIN

RDD:  $x$

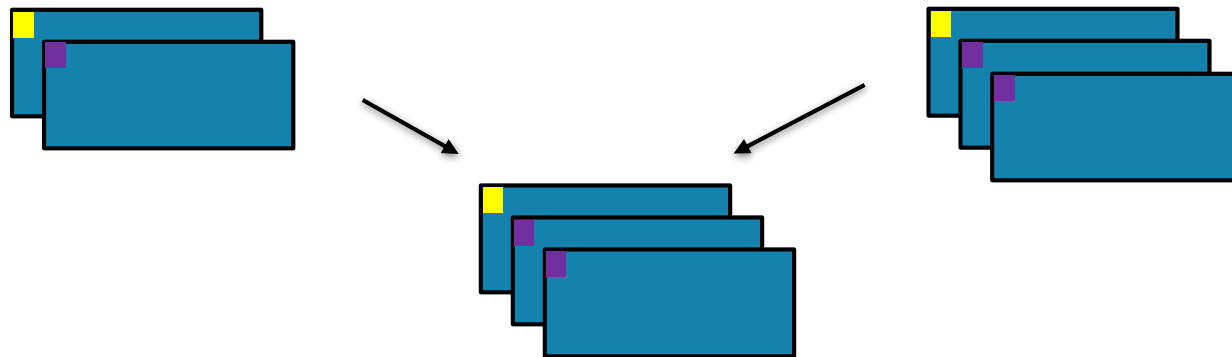


RDD:  $y$





# JOIN



Return a new RDD containing all pairs of elements having the same key in the original RDDs

`union(otherRDD, numPartitions=None)`



```
x = sc.parallelize([("a", 1), ("b", 2)])  
y = sc.parallelize([("a", 3), ("a", 4), ("b", 5)])  
z = x.join(y)  
print(z.collect())
```



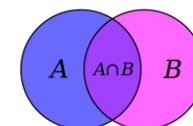
**x:** [("a", 1), ("b", 2)]

**y:** [("a", 3), ("a", 4), ("b", 5)]

**z:** [('a', (1, 3)), ('a', (1, 4)), ('b', (2, 5))]



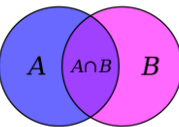
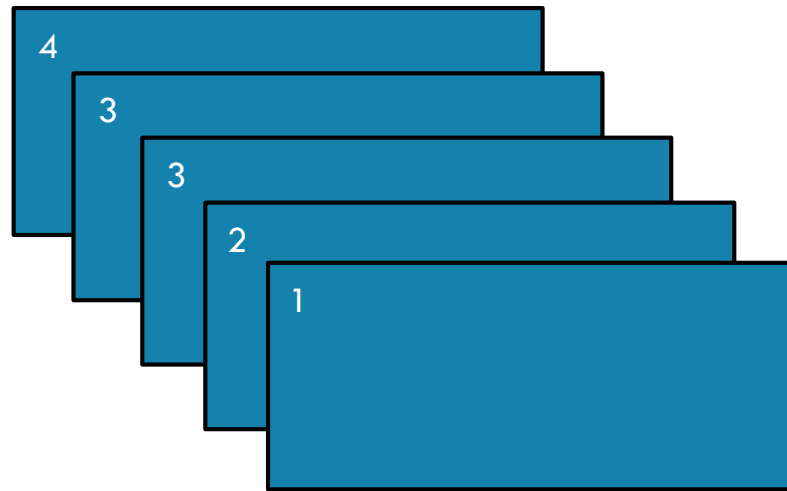
```
val x = sc.parallelize(Array(("a", 1), ("b", 2)))  
val y = sc.parallelize(Array(("a", 3), ("a", 4), ("b", 5)))  
val z = x.join(y)  
println(z.collect().mkString(", "))
```





# DISTINCT

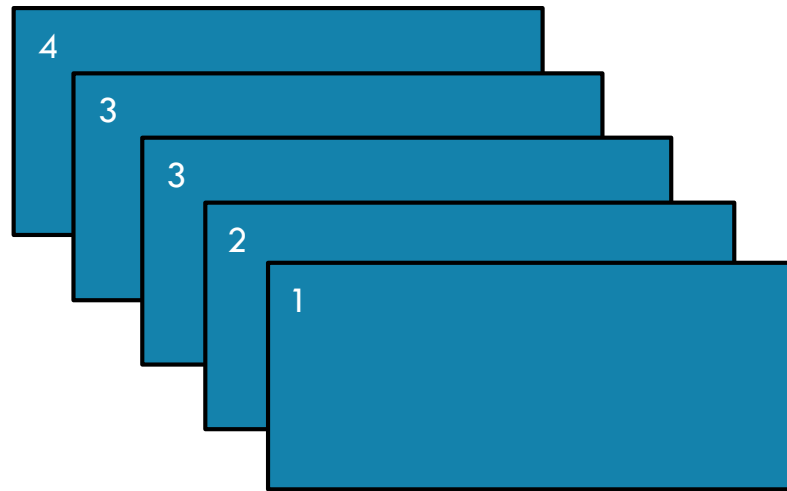
RDD:  $x$



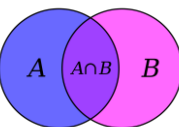
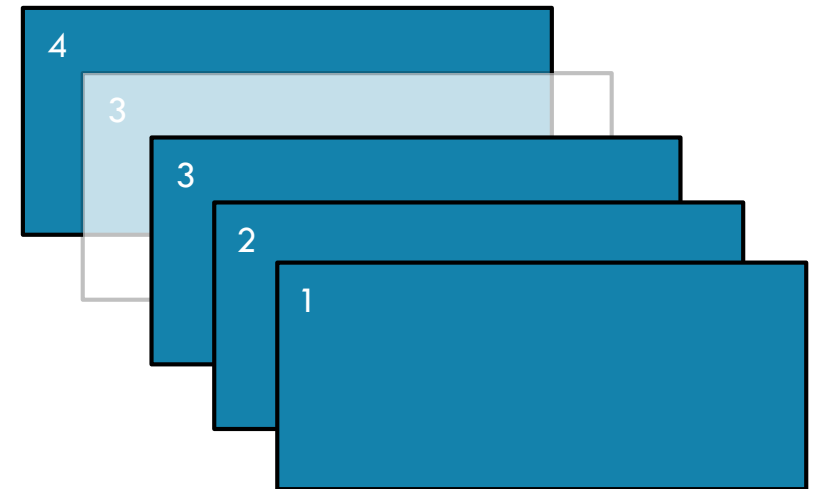


# DISTINCT

RDD:  $x$



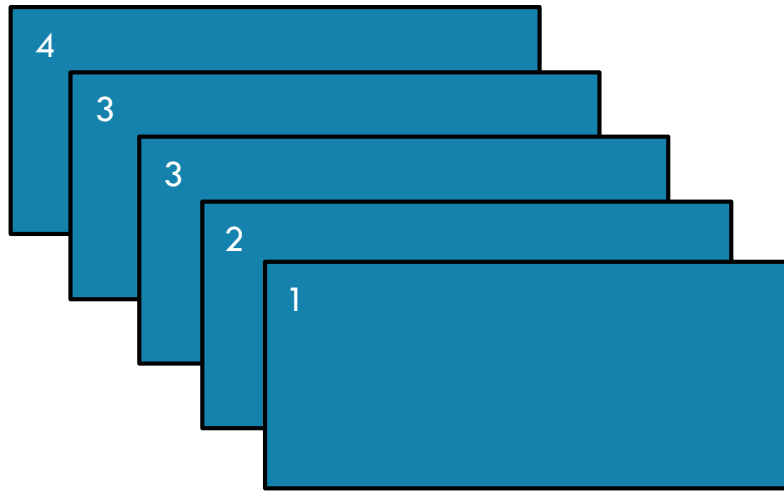
RDD:  $y$



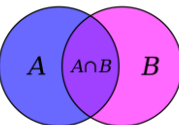
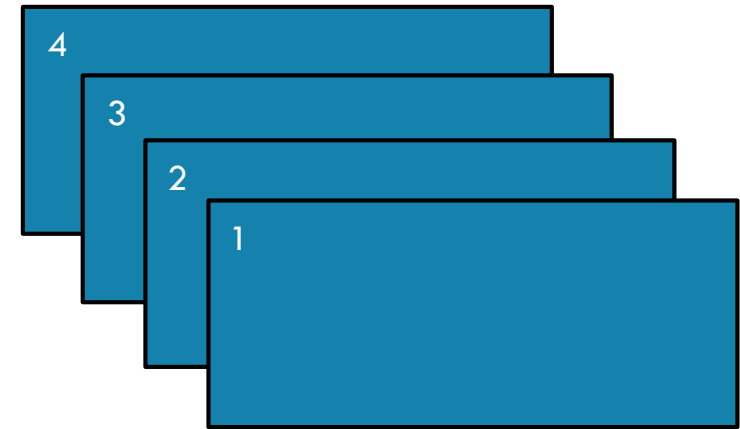


# DISTINCT

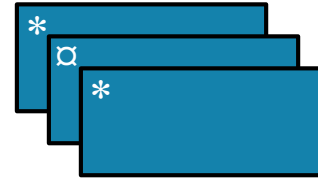
RDD:  $x$



RDD:  $y$



# DISTINCT



Return a new RDD containing distinct items from the original RDD (omitting all duplicates)  
`distinct(numPartitions=None)`



```
x = sc.parallelize([1,2,3,3,4])  
y = x.distinct()  
  
print(y.collect())
```

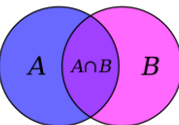


```
val x = sc.parallelize(Array(1,2,3,3,4))  
val y = x.distinct()  
  
println(y.collect().mkString(", "))
```



**x:** [1, 2, 3, 3, 4]

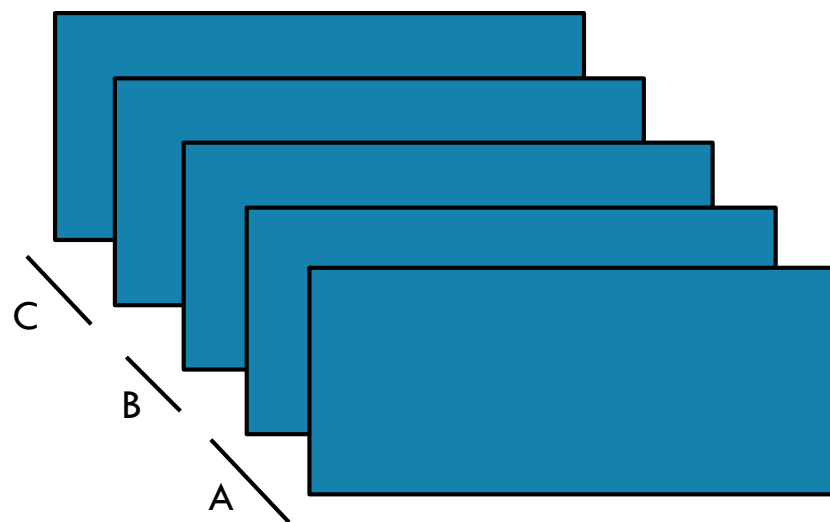
**y:** [1, 2, 3, 4]





# COALESCE

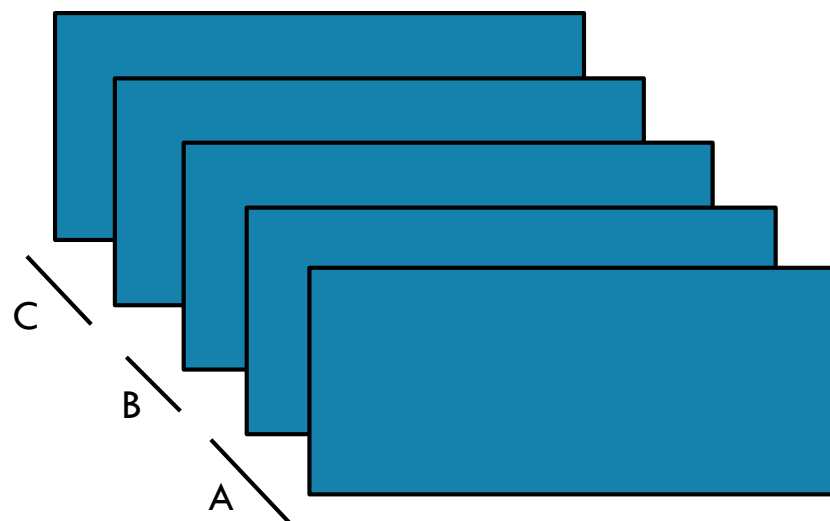
RDD: x



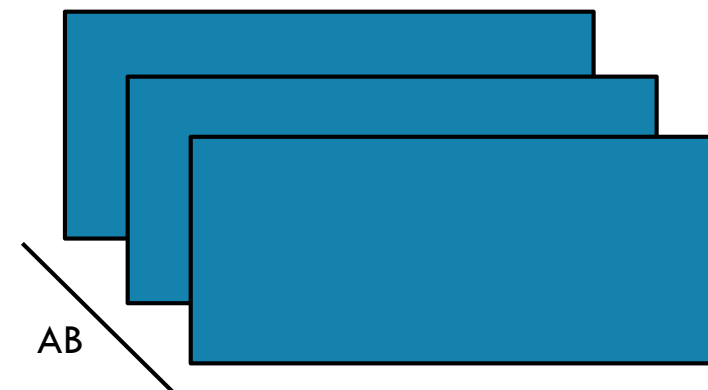


# COALESCE

RDD: **x**



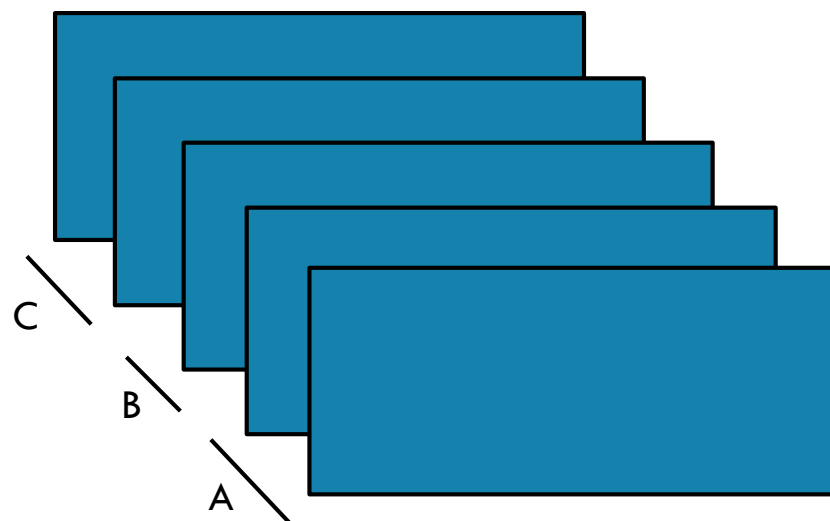
RDD: **y**



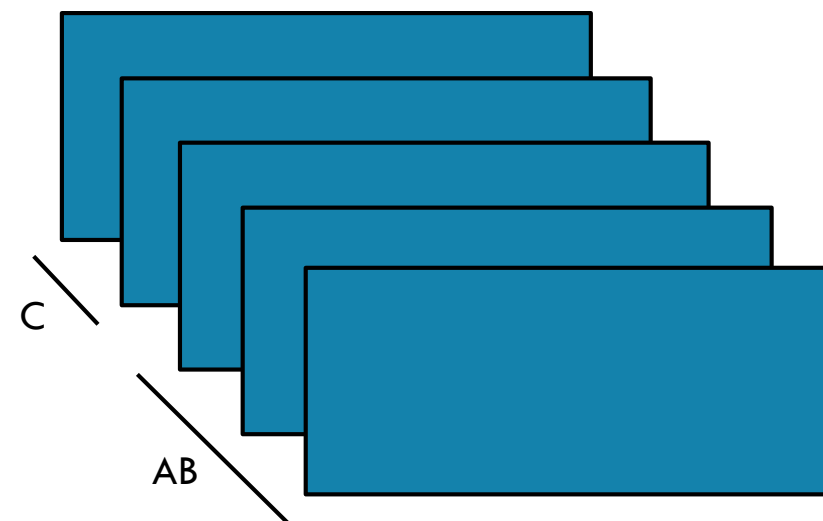


# COALESCE

RDD: **x**

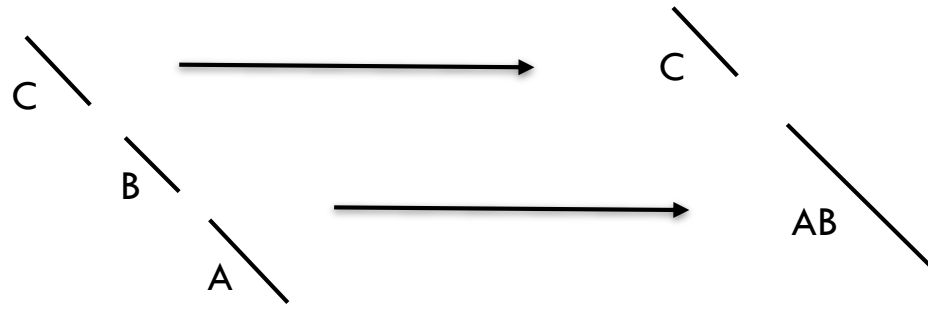


RDD: **y**





# COALESCE



Return a new RDD which is reduced to a smaller number of partitions

`coalesce(numPartitions, shuffle=False)`



```
x = sc.parallelize([1, 2, 3, 4, 5], 3)
y = x.coalesce(2)
print(x.glom().collect())
print(y.glom().collect())
```



**x:** [[1], [2, 3], [4, 5]]

**y:** [[1], [2, 3, 4, 5]]



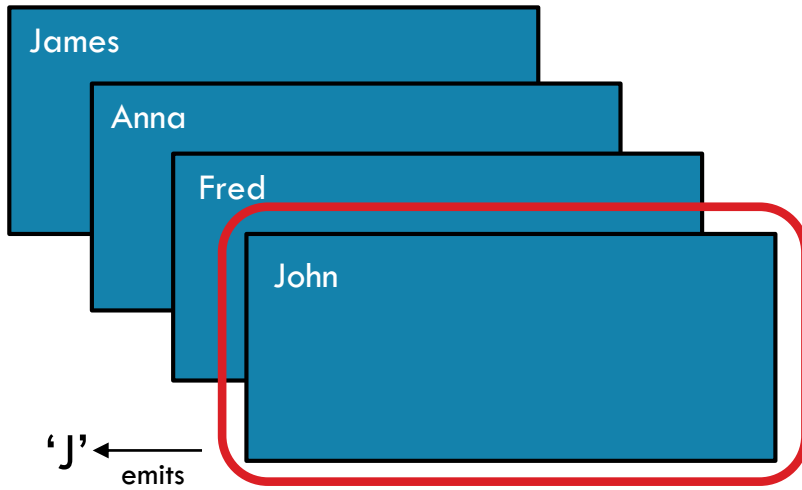
```
val x = sc.parallelize(Array(1, 2, 3, 4, 5), 3)
val y = x.coalesce(2)
val xOut = x.glom().collect()
val yOut = y.glom().collect()
```



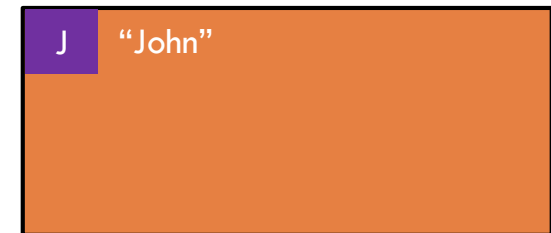


# KEYBY

RDD: **x**



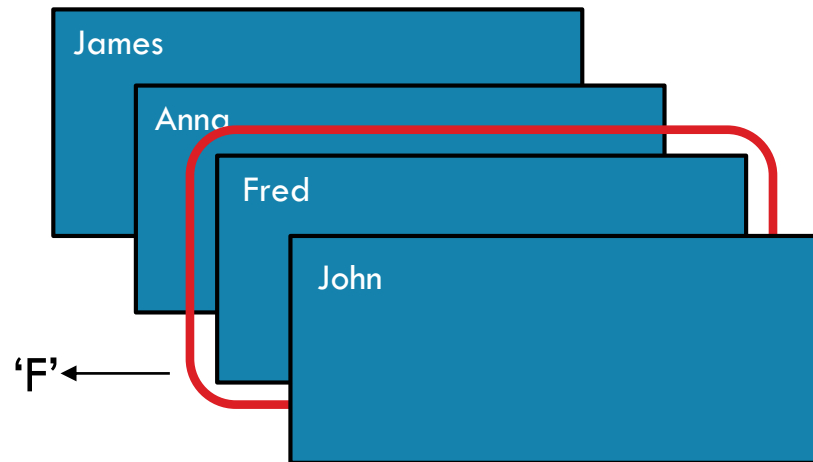
RDD: **y**



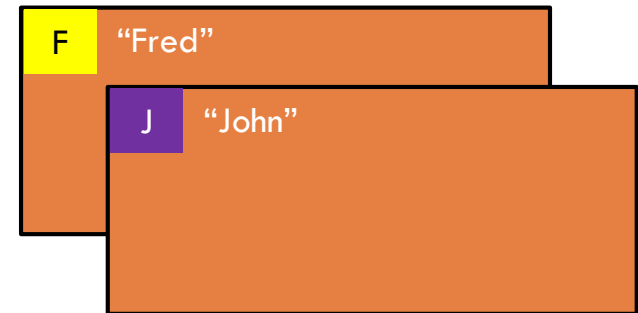


# KEYBY

RDD: **x**



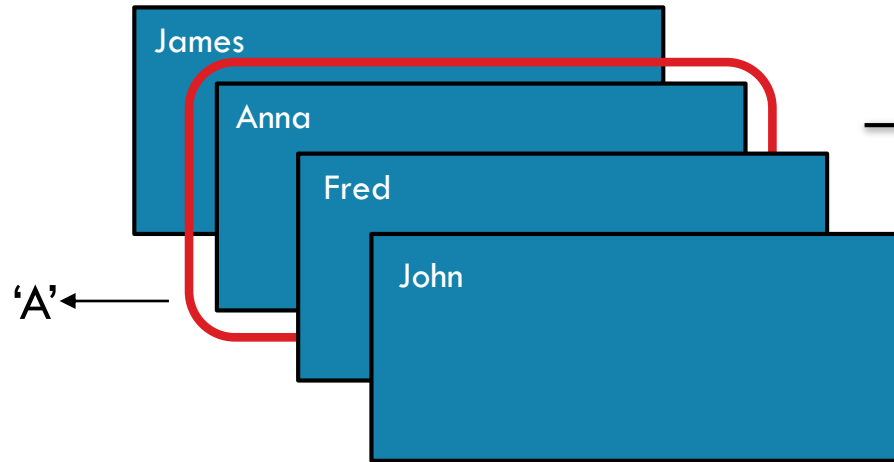
RDD: **y**



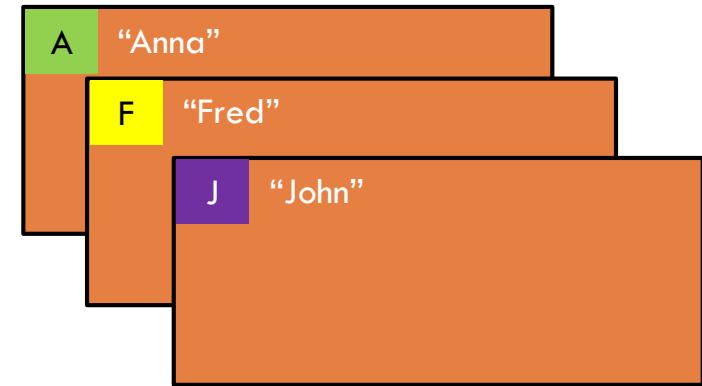


# KEYBY

RDD: **x**



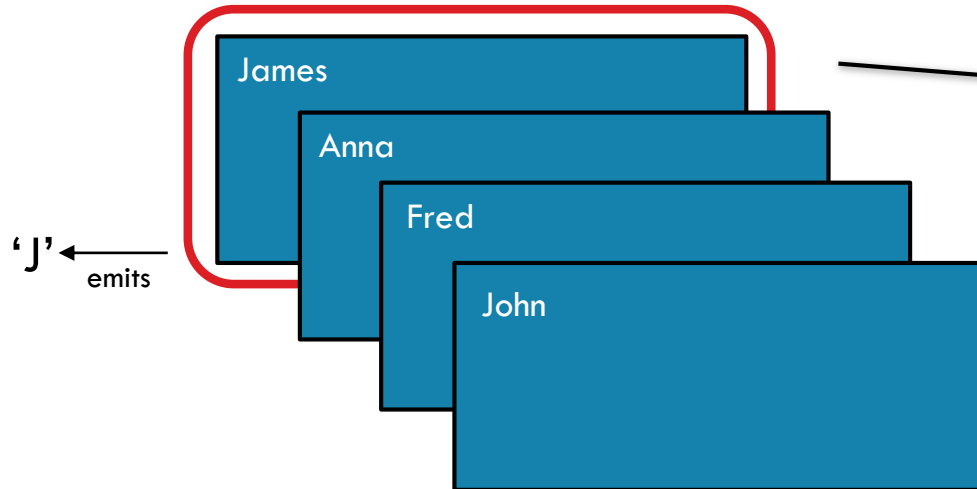
RDD: **y**



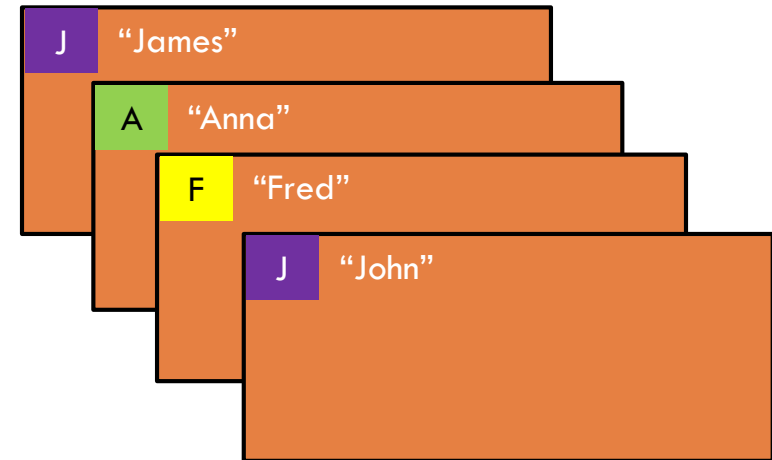


# KEYBY

RDD: **x**



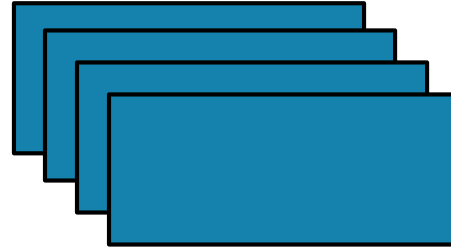
RDD: **y**



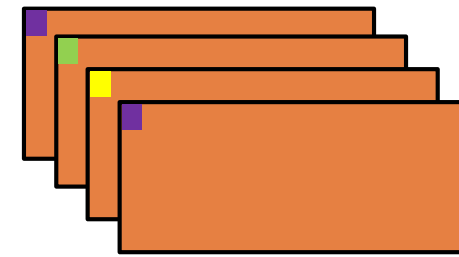


# KEYBY

RDD: **x**



RDD: **y**



keyBy(**f**)

Create a Pair RDD, forming one pair for each item in the original RDD. The pair's key is calculated from the value via a user-supplied function.



```
x = sc.parallelize(['John', 'Fred', 'Anna', 'James'])  
y = x.keyBy(lambda w: w[0])  
print y.collect()
```



**x:** ['John', 'Fred', 'Anna', 'James']

**y:** [('J', 'John'), ('F', 'Fred'), ('A', 'Anna'), ('J', 'James')]



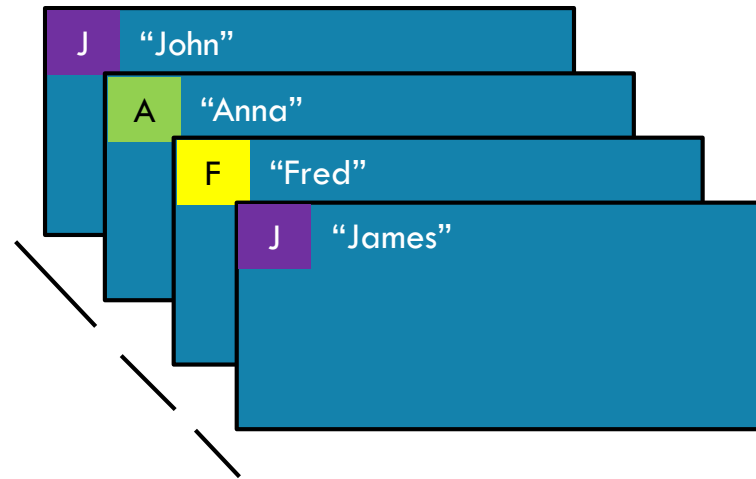
```
val x = sc.parallelize(  
    Array("John", "Fred", "Anna", "James"))  
val y = x.keyBy(w => w.charAt(0))  
println(y.collect().mkString(", "))
```





# PARTITIONBY

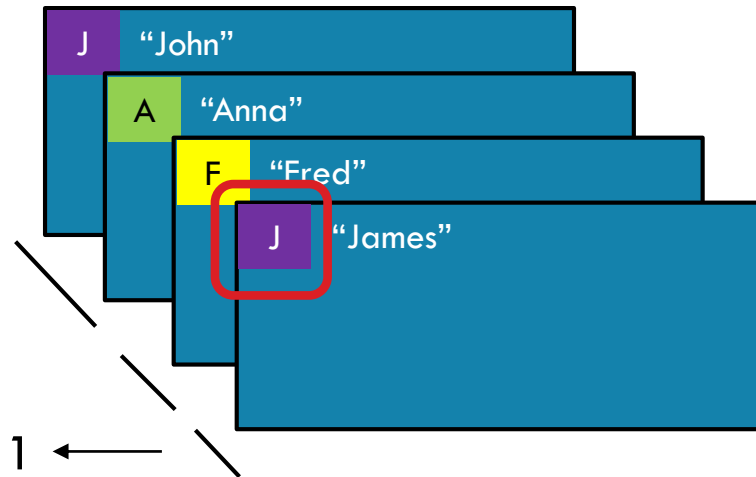
RDD: x



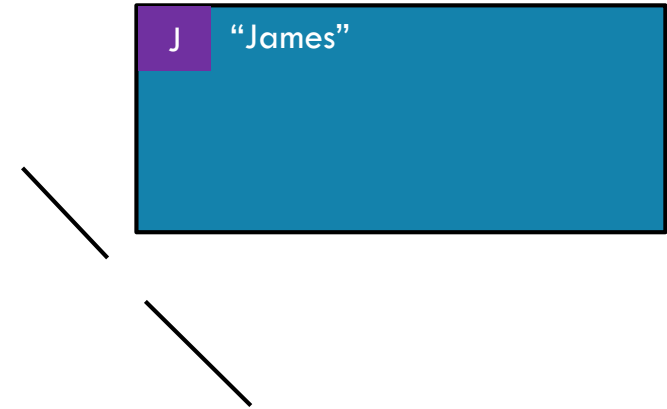


# PARTITIONBY

RDD: **x**



RDD: **y**

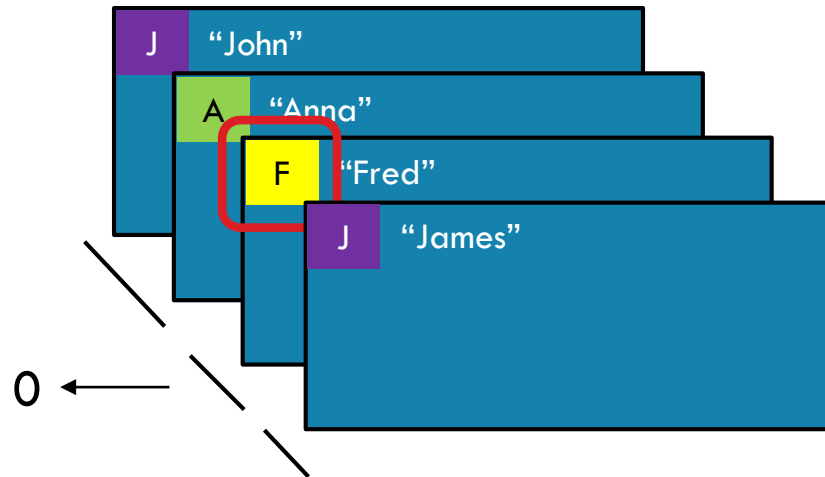




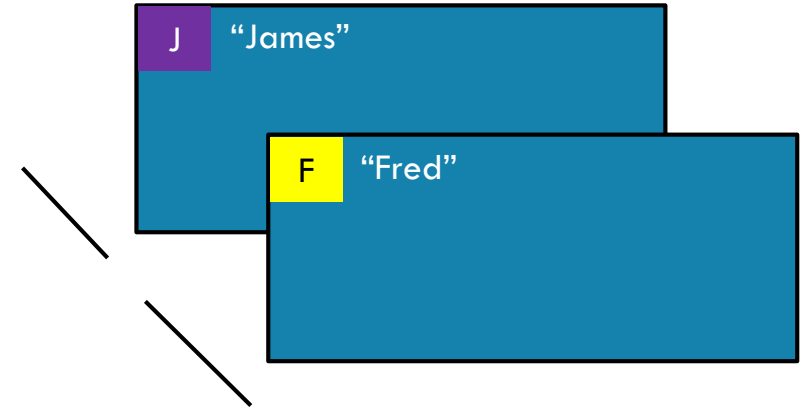


# PARTITIONBY

RDD: **x**



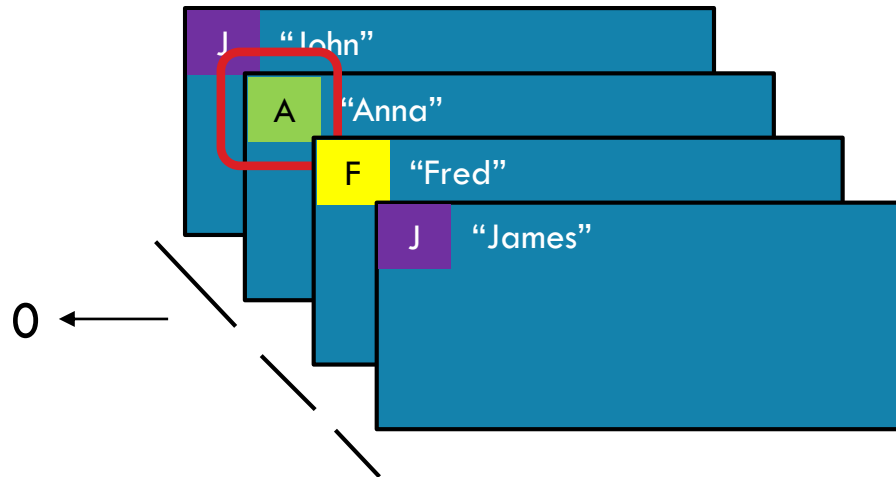
RDD: **y**



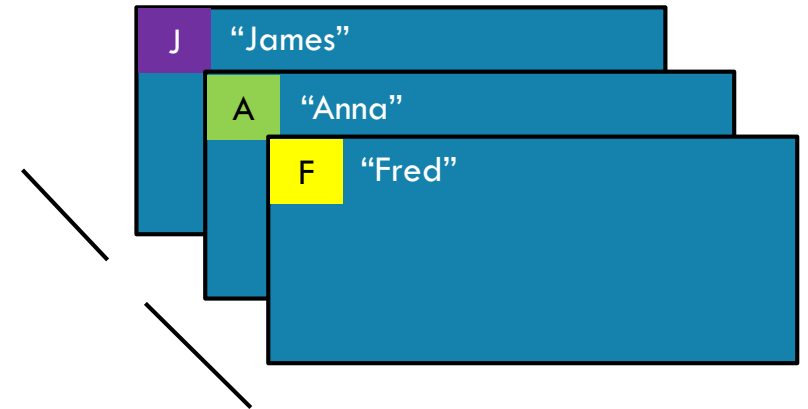


# PARTITIONBY

RDD: **x**



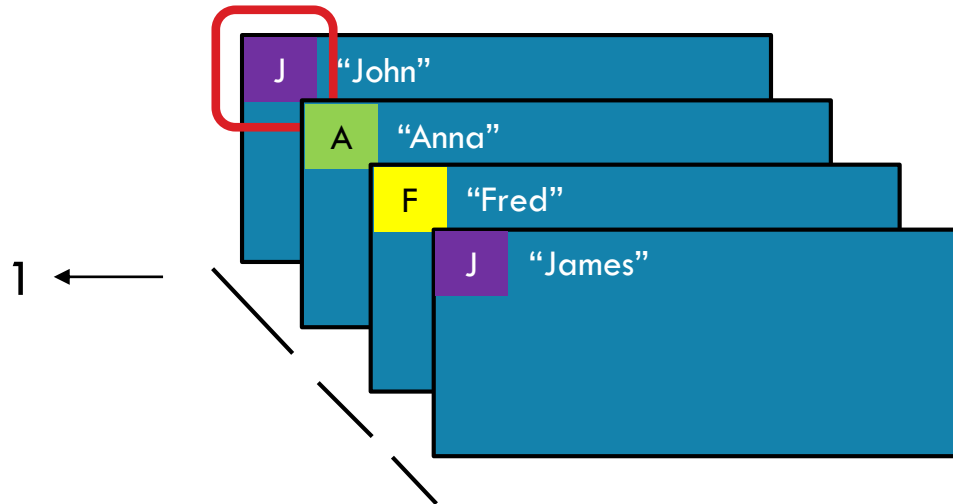
RDD: **y**



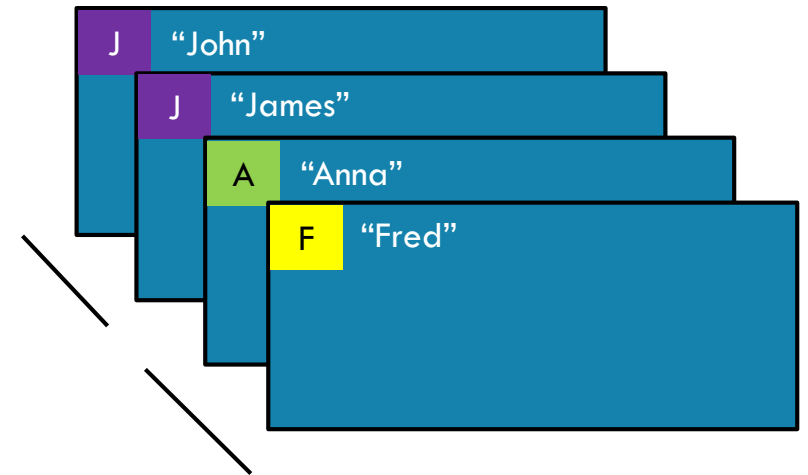


# PARTITIONBY

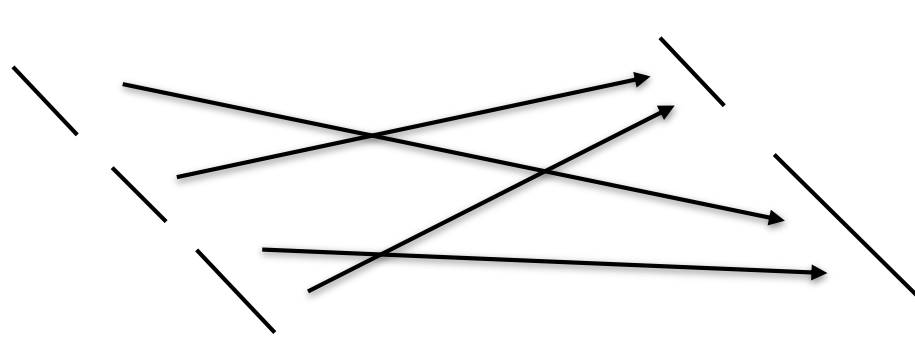
RDD: **x**



RDD: **y**



# PARTITIONBY



Return a new RDD with the specified number of partitions, placing original items into the partition returned by a user supplied function

`partitionBy(numPartitions, partitioner=portable_hash)`



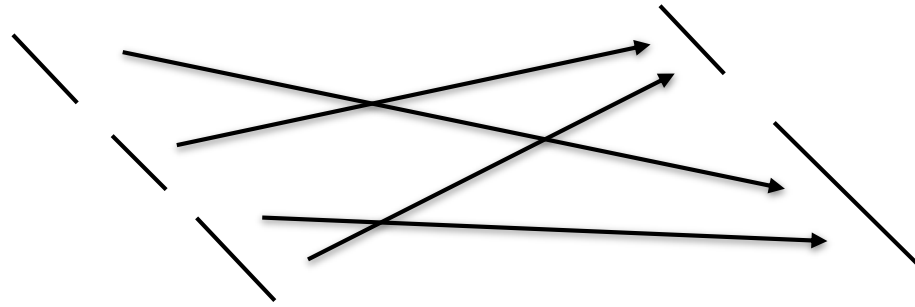
```
x = sc.parallelize([('J','James'),('F','Fred'),  
                    ('A','Anna'),('J','John')], 3)  
  
y = x.partitionBy(2, lambda w: 0 if w[0] < 'H' else 1)  
print x.glom().collect()  
print y.glom().collect()
```



```
x: [[('J', 'James')], [('F', 'Fred')],  
    [('A', 'Anna'), ('J', 'John')]]  
  
y: [[('A', 'Anna'), ('F', 'Fred')],  
    [('J', 'James'), ('J', 'John')]]
```



# PARTITIONBY



Return a new RDD with the specified number of partitions, placing original items into the partition returned by a user supplied function.

`partitionBy(numPartitions, partitioner=portable_hash)`

```
import org.apache.spark.Partitioner
val x = sc.parallelize(Array(('J',"James"),('F',"Fred"),
                           ('A',"Anna"),('J',"John")), 3)
```

```
val y = x.partitionBy(new Partitioner() {
  val numPartitions = 2
  def getPartition(k:Any) = {
    if (k.asInstanceOf[Char] < 'H') 0 else 1
  }
})
```

```
val y0ut = y.glom().collect()
```



**x:** Array(Array((A,Anna), (F,Fred)),  
 Array((J,John), (J,James)))

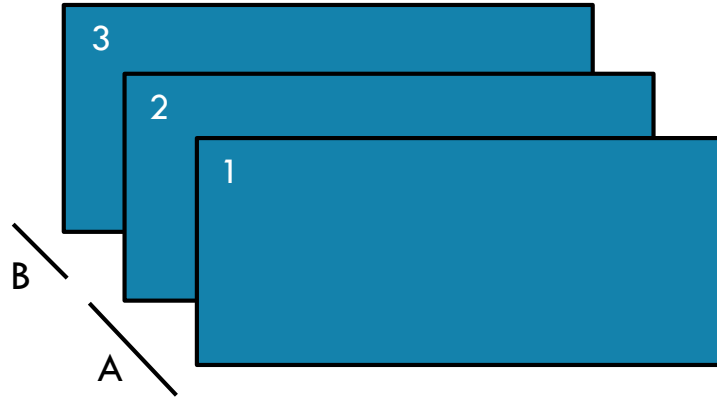
**y:** Array(Array((F,Fred), (A,Anna)),  
 Array((J,John), (J,James)))



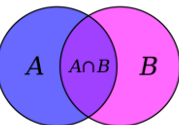
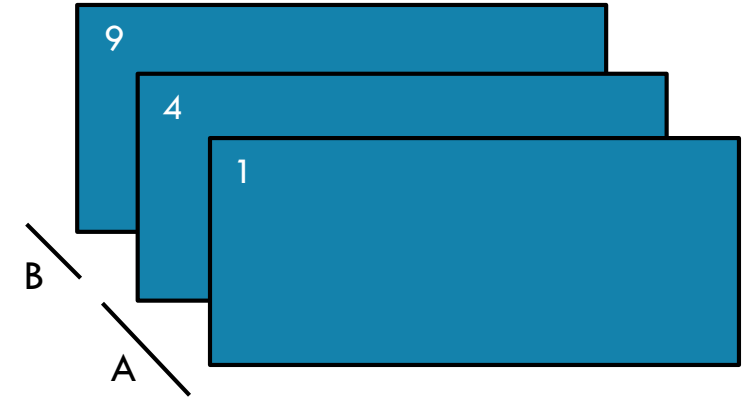


# ZIP

RDD: **x**

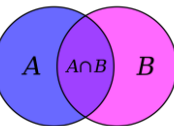
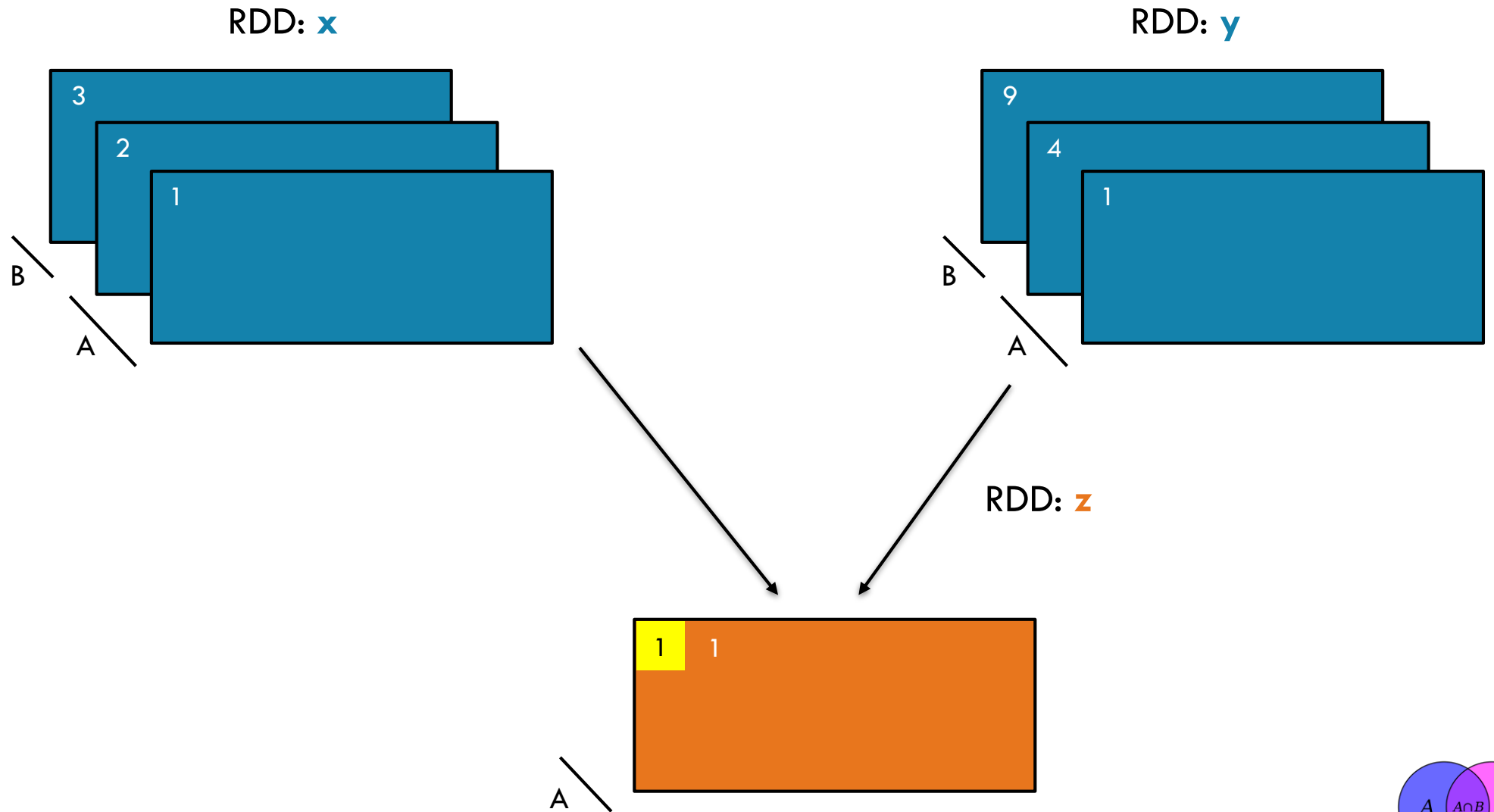


RDD: **y**



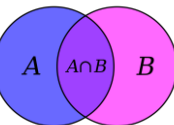
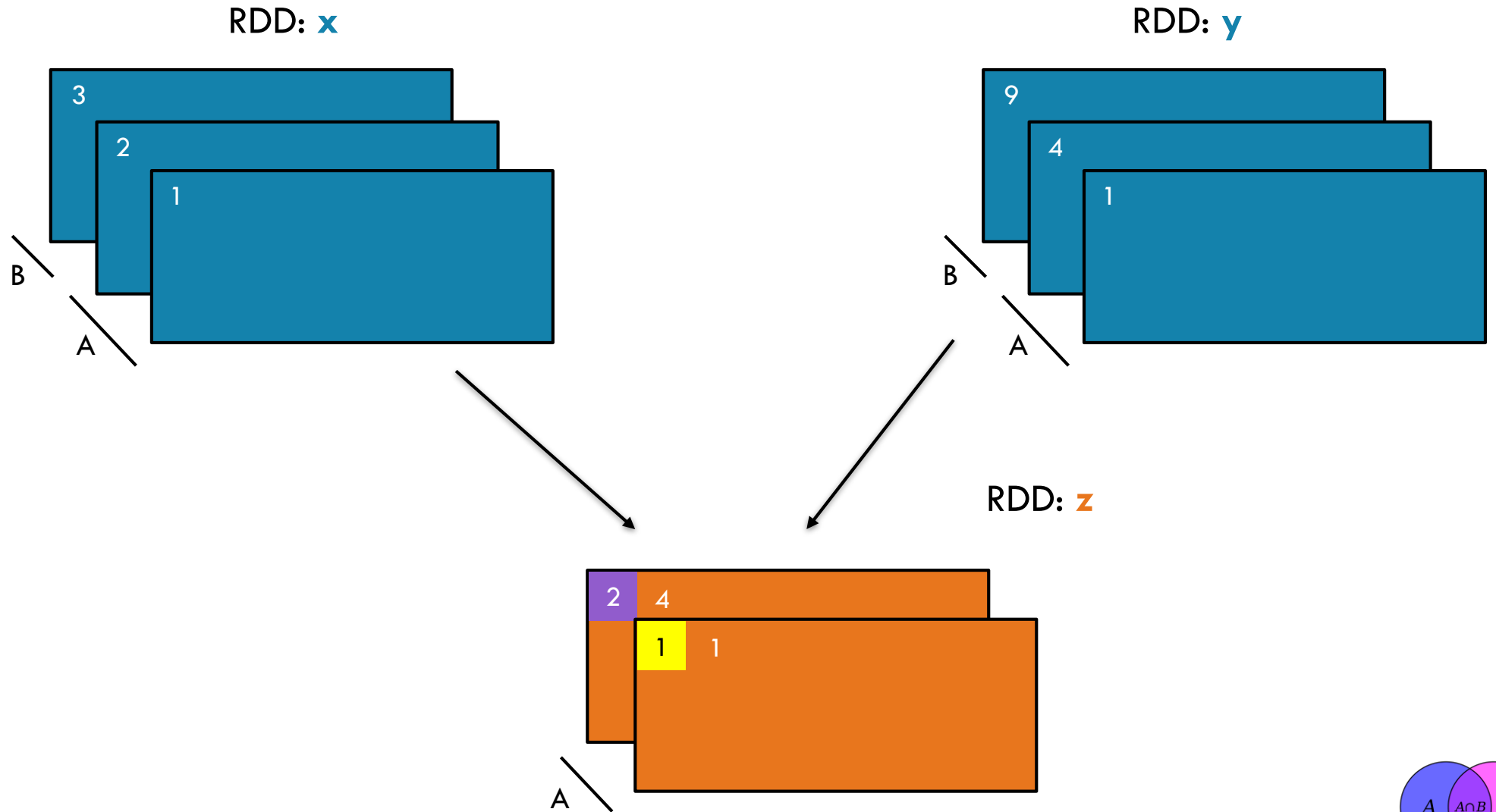


# ZIP





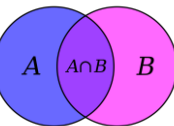
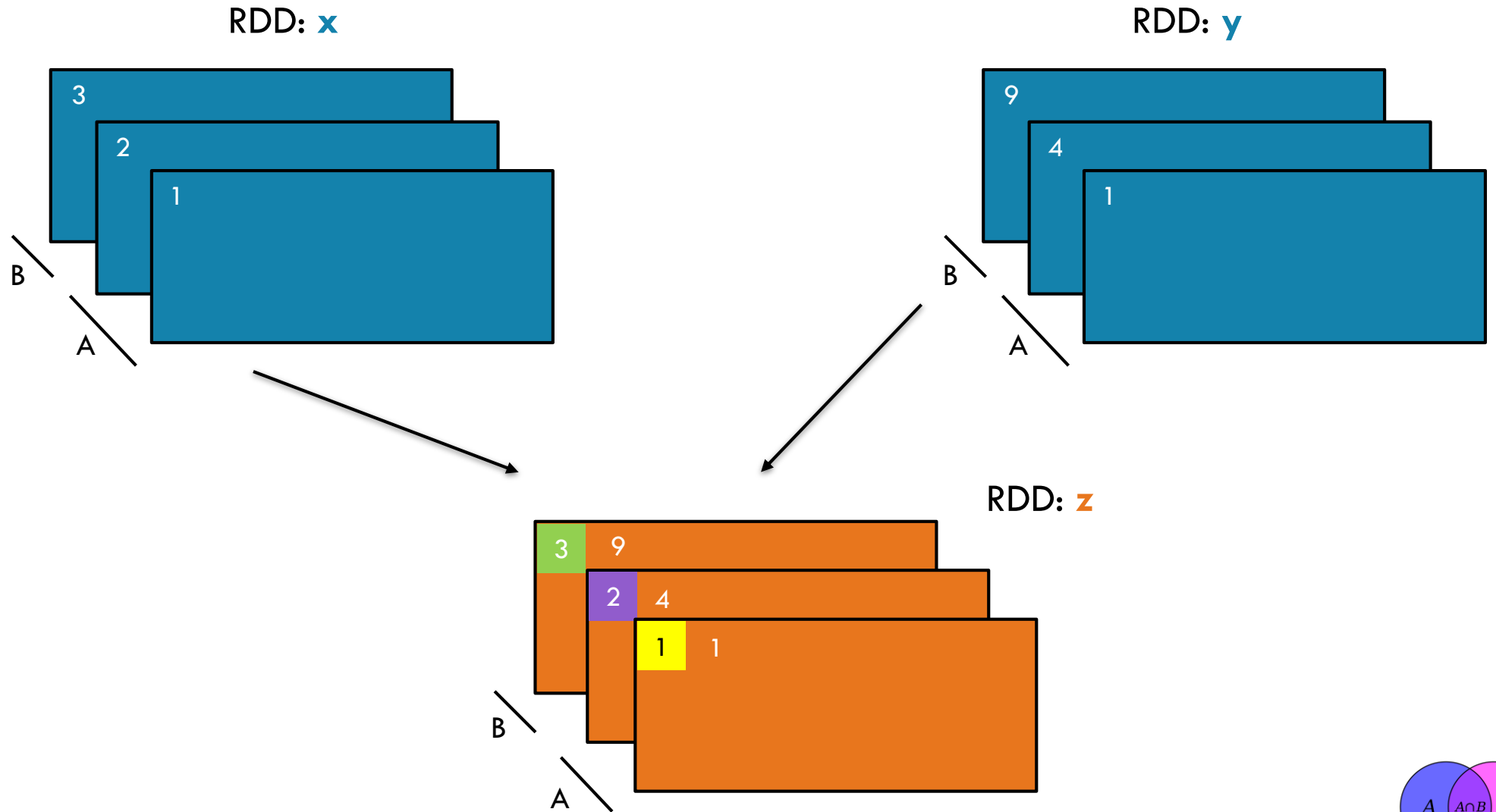
# ZIP



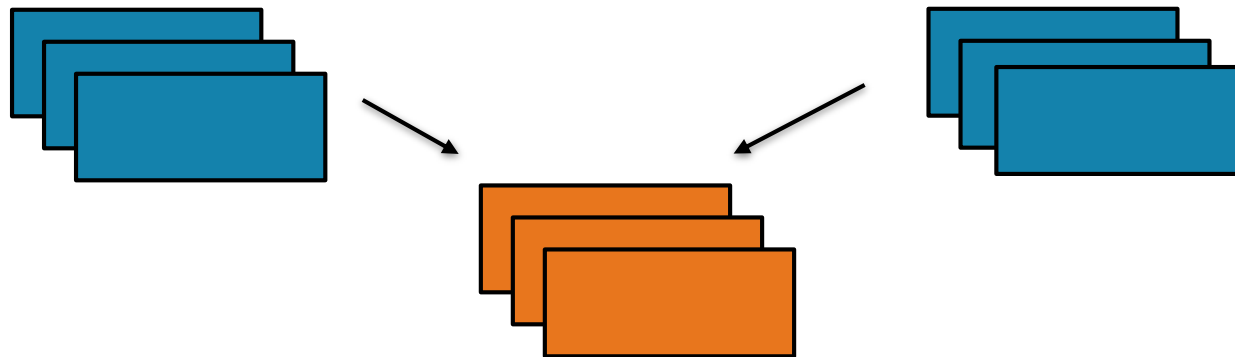




# ZIP



# ZIP



Return a new RDD containing pairs whose key is the item in the original RDD, and whose value is that item's corresponding element (same partition, same index) in a second RDD

`zip(otherRDD)`



```
x = sc.parallelize([1, 2, 3])  
y = x.map(lambda n:n*n)  
z = x.zip(y)
```

```
print(z.collect())
```



```
val x = sc.parallelize(Array(1,2,3))  
val y = x.map(n=>n*n)  
val z = x.zip(y)
```

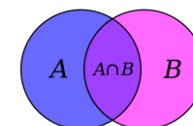
```
println(z.collect().mkString(", "))
```

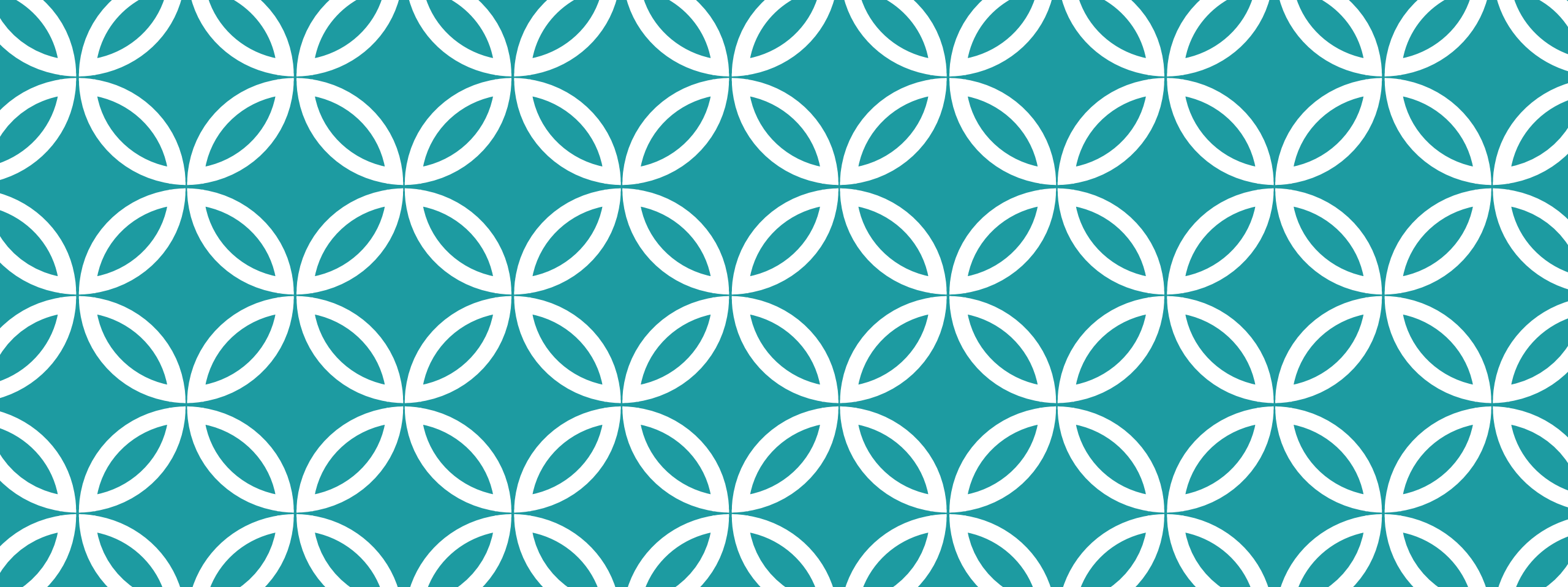


`x:` [1, 2, 3]

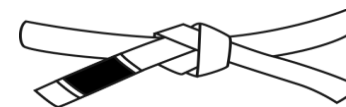
`y:` [1, 4, 9]

`z:` [(1, 1), (2, 4), (3, 9)]

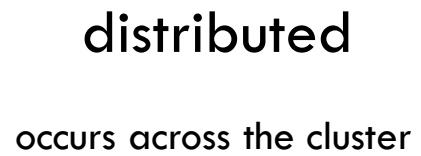




**ACTIONS**



Core Operations

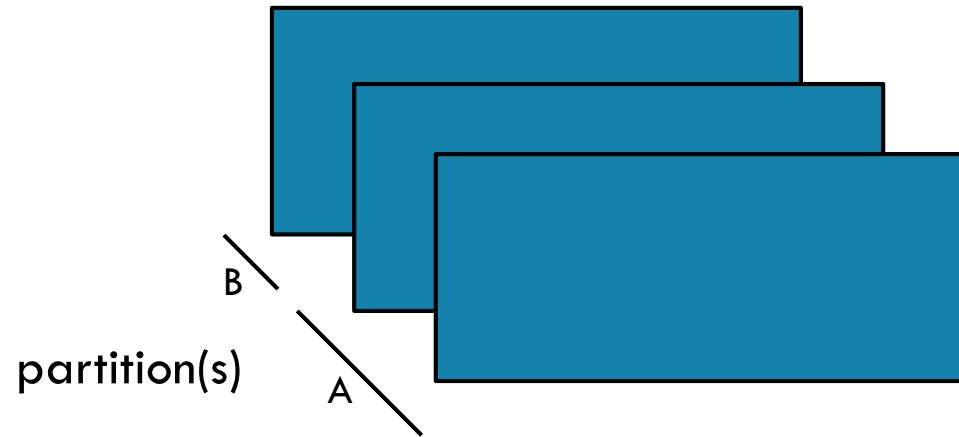


driver

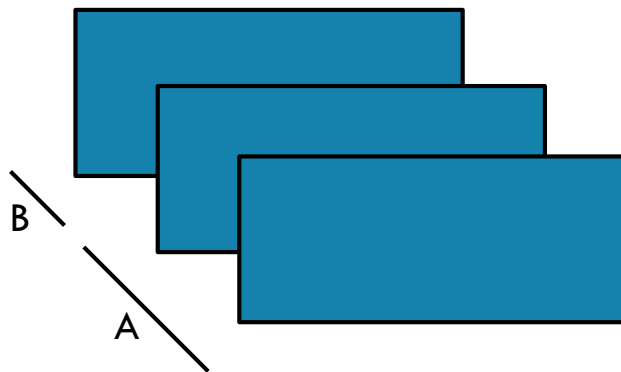
result must fit in driver JVM



# GETNUMPARTITIONS



# GETNUMPARTITIONS



`getNumPartitions()`

Return the number of partitions in RDD



```
x = sc.parallelize([1,2,3], 2)
y = x.getNumPartitions()

print(x.glom().collect())
print(y)
```



```
val x = sc.parallelize(Array(1,2,3), 2)
val y = x.partitions.size
val xOut = x.glom().collect()
println(y)
```

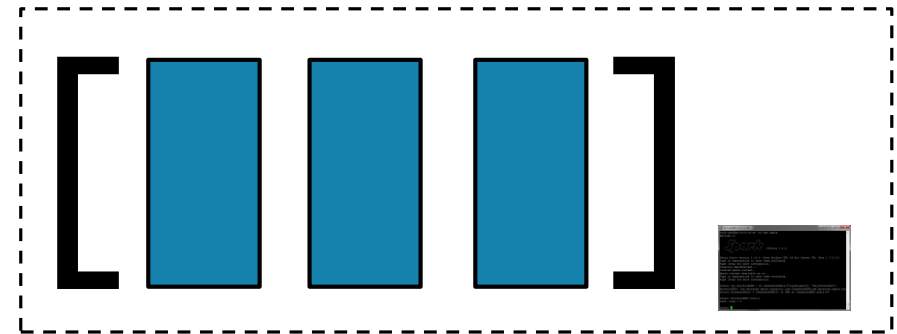
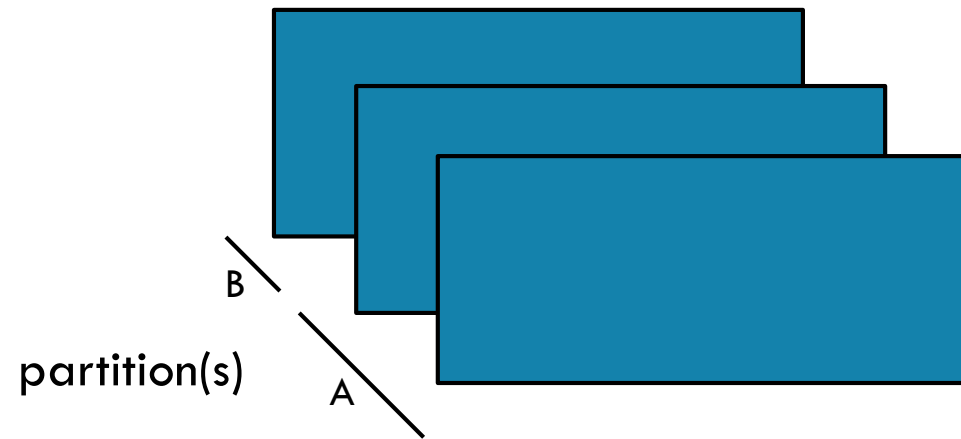


`x:` `[[1], [2, 3]]`

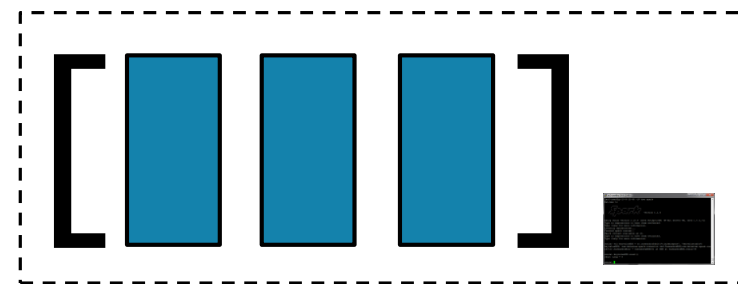
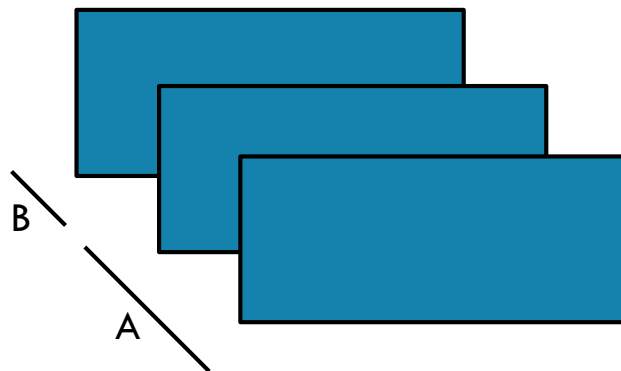
`y:` `2`



# COLLECT



# COLLECT



`collect()`

Return all items in the RDD to the driver in a single list



```
x = sc.parallelize([1,2,3], 2)
y = x.collect()

print(x.glom().collect())
print(y)
```



```
val x = sc.parallelize(Array(1,2,3), 2)
val y = x.collect()

val xOut = x.glom().collect()
println(y)
```



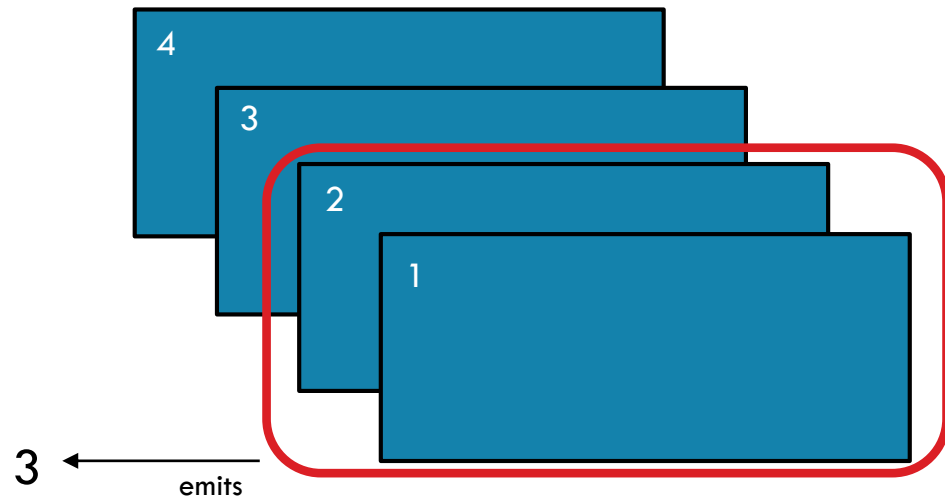
`x:` `[[1], [2, 3]]`

`y:` `[1, 2, 3]`

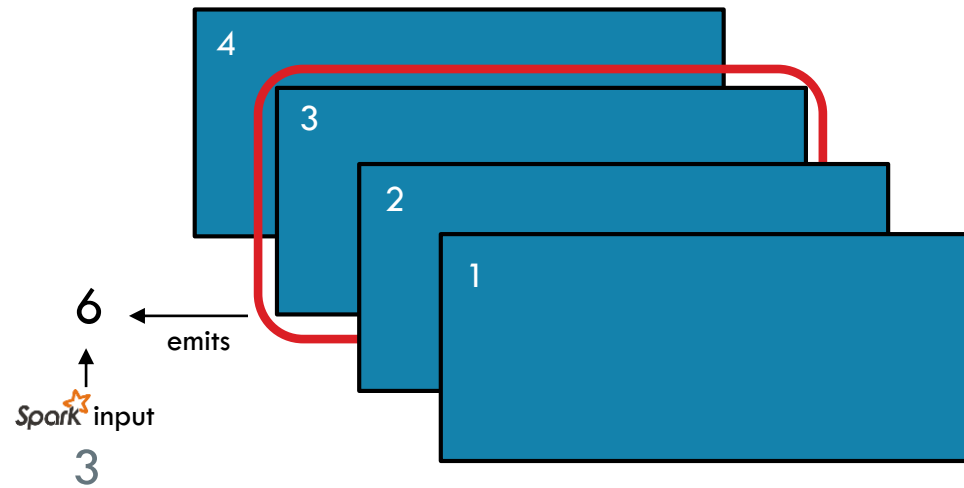




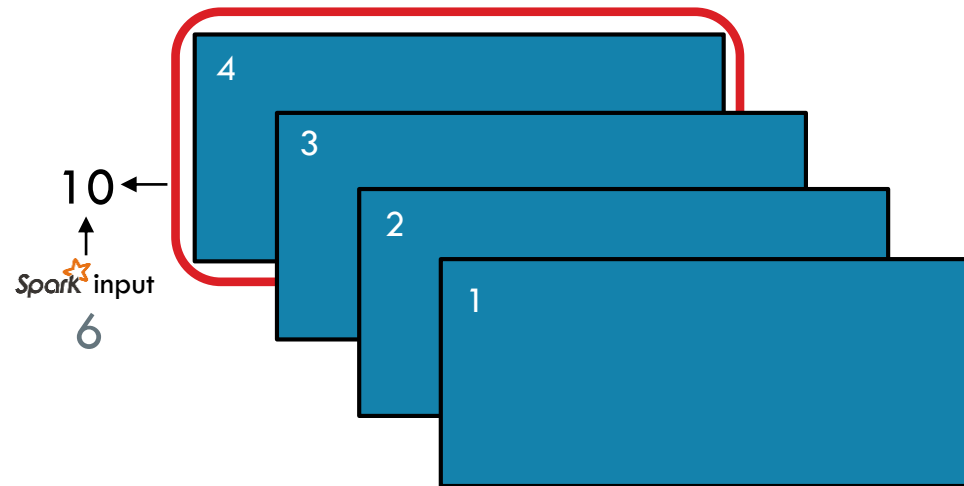
# REDUCE



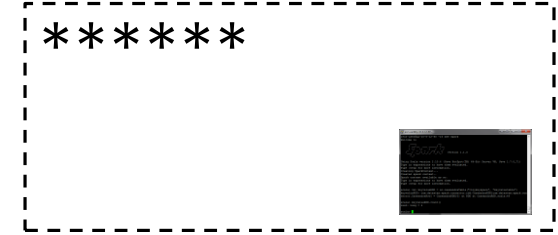
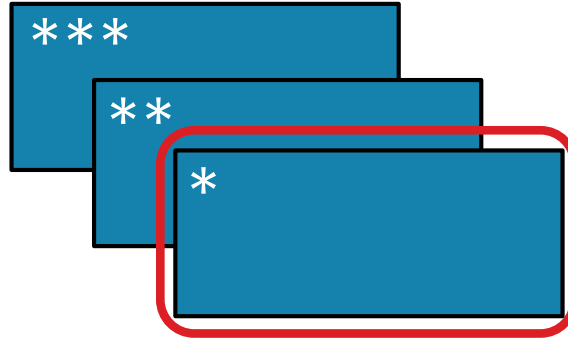
# REDUCE



# REDUCE



# REDUCE



`reduce(f)`

Aggregate all the elements of the RDD by applying a user function pairwise to elements and partial results, and returns a result to the driver



```
x = sc.parallelize([1,2,3,4])
y = x.reduce(lambda a,b: a+b)

print(x.collect())
print(y)
```



```
val x = sc.parallelize(Array(1,2,3,4))
val y = x.reduce((a,b) => a+b)

println(x.collect.mkString(", "))
println(y)
```

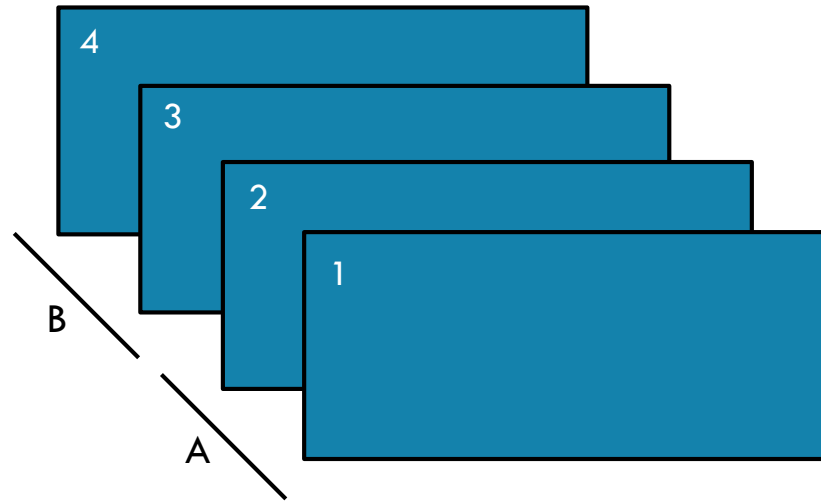


**x:** [1, 2, 3, 4]

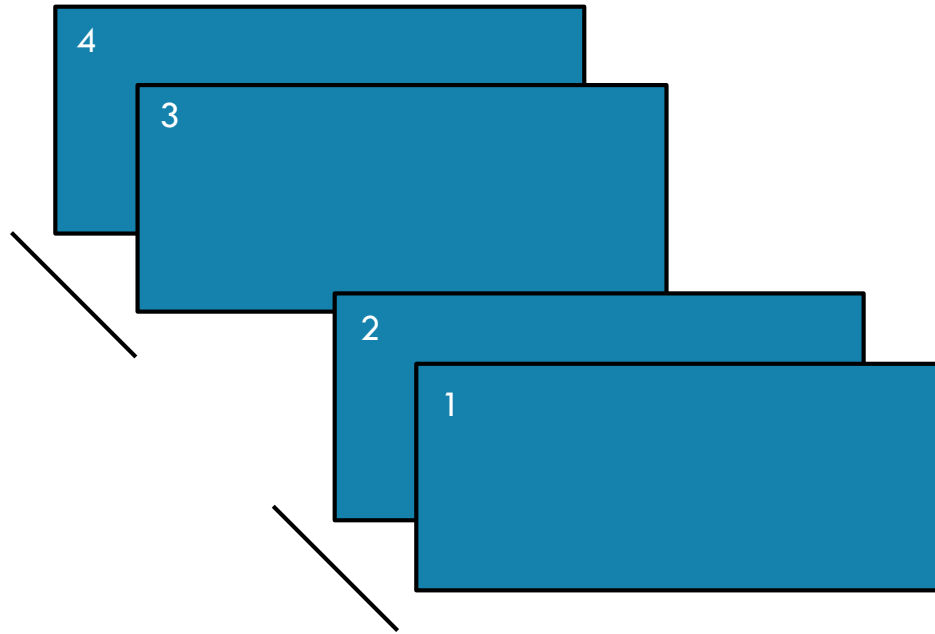
**y:** 10



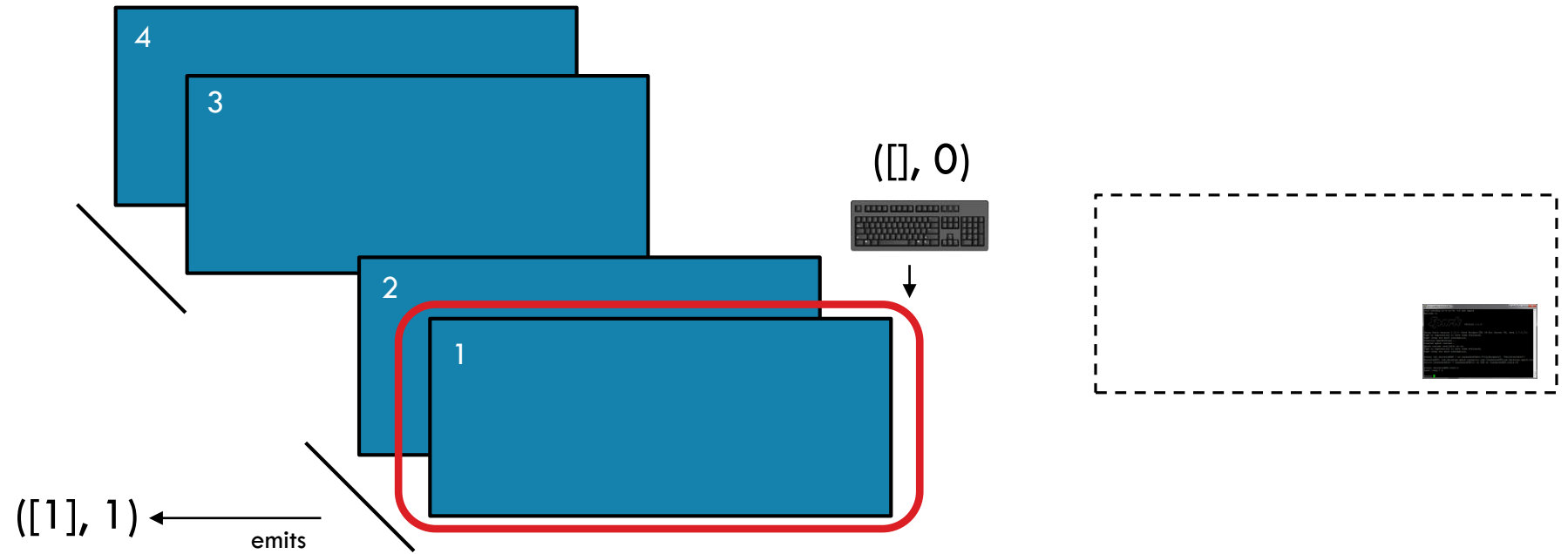
# AGGREGATE



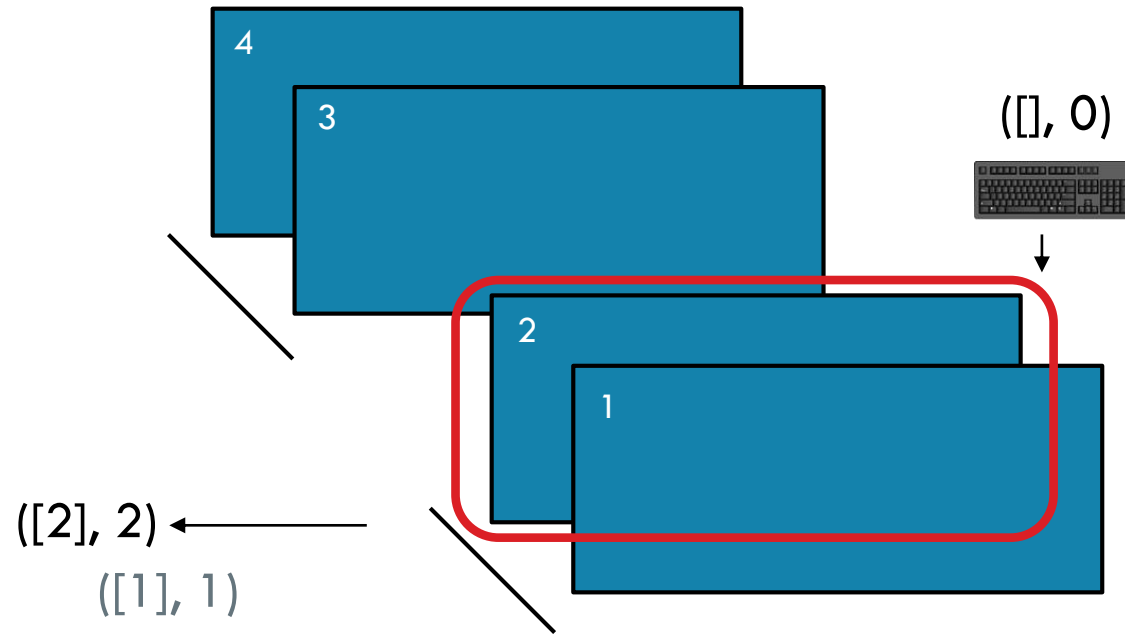
# AGGREGATE



# AGGREGATE

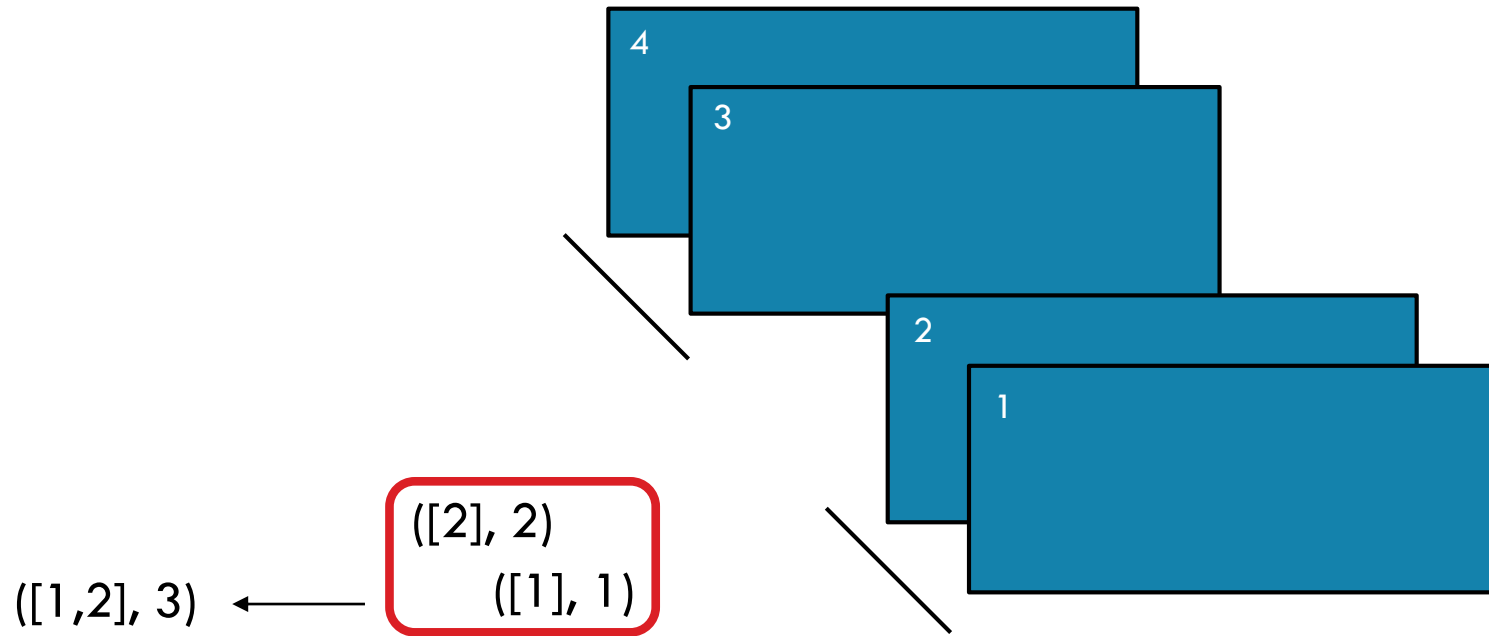


# AGGREGATE

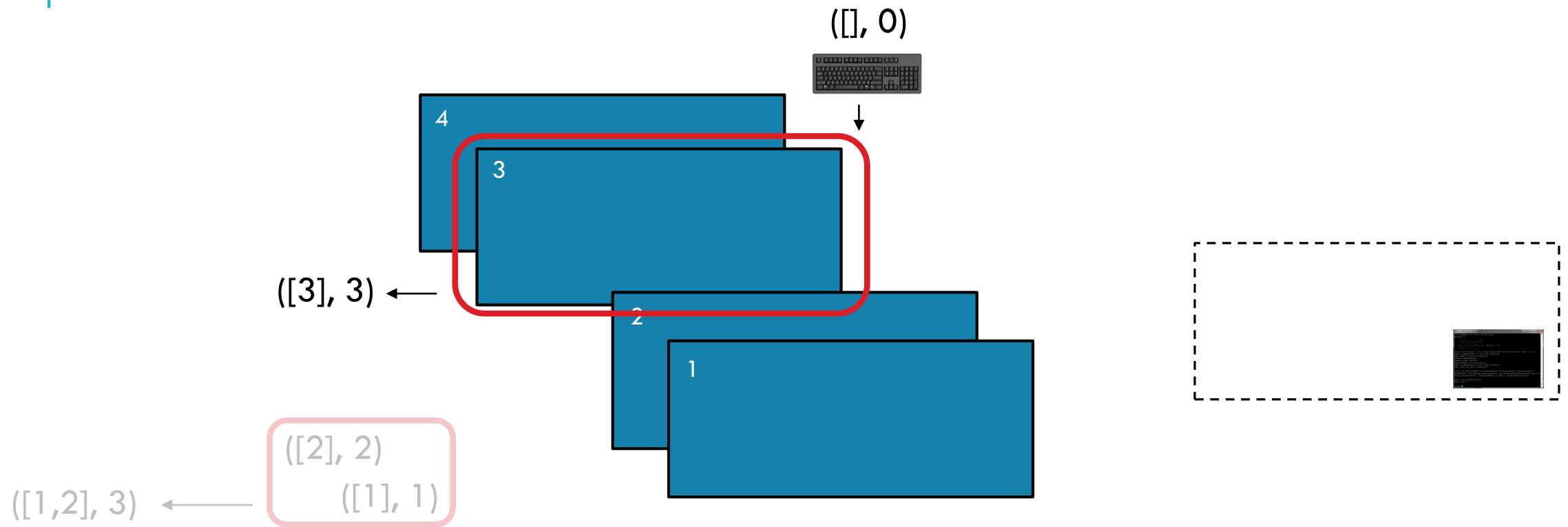




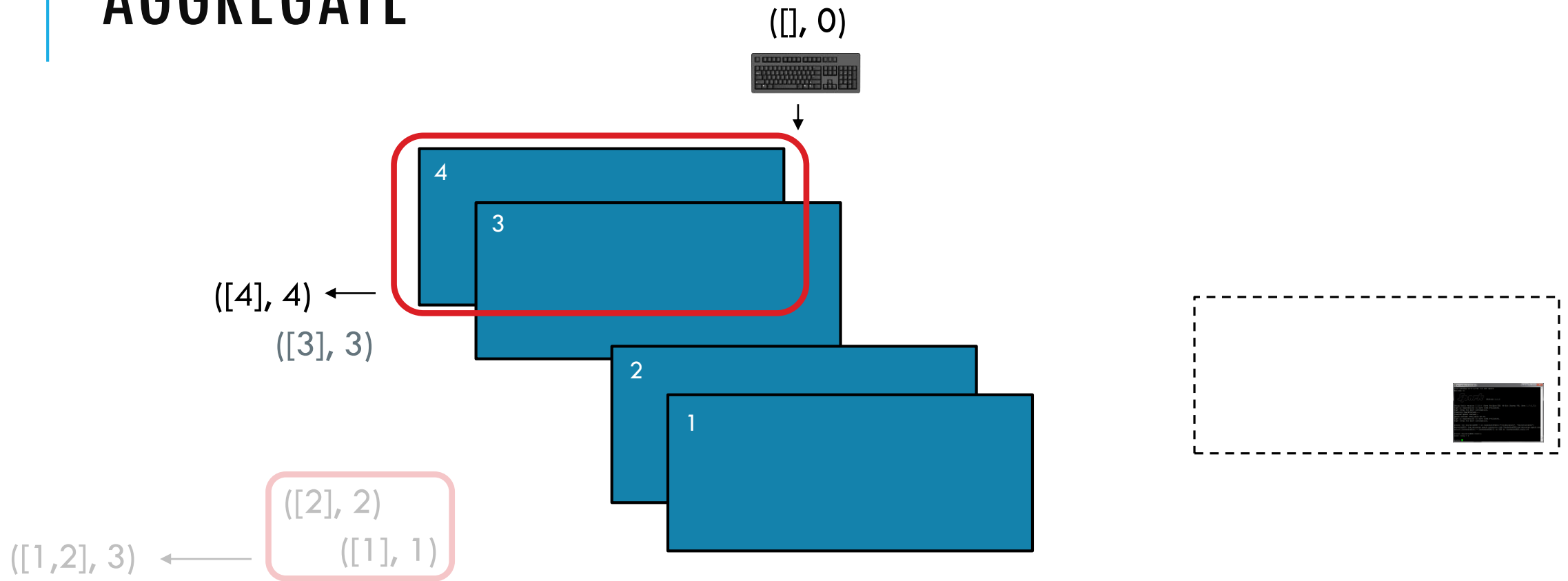
# AGGREGATE



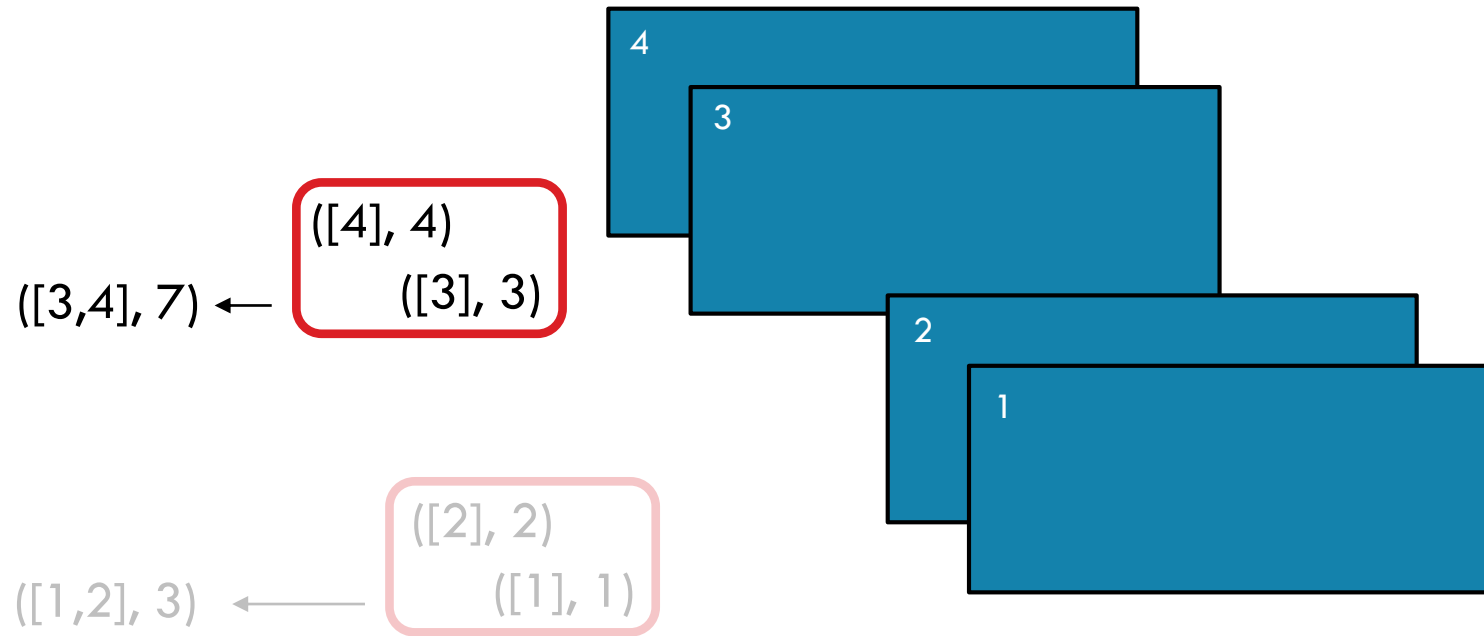
# AGGREGATE



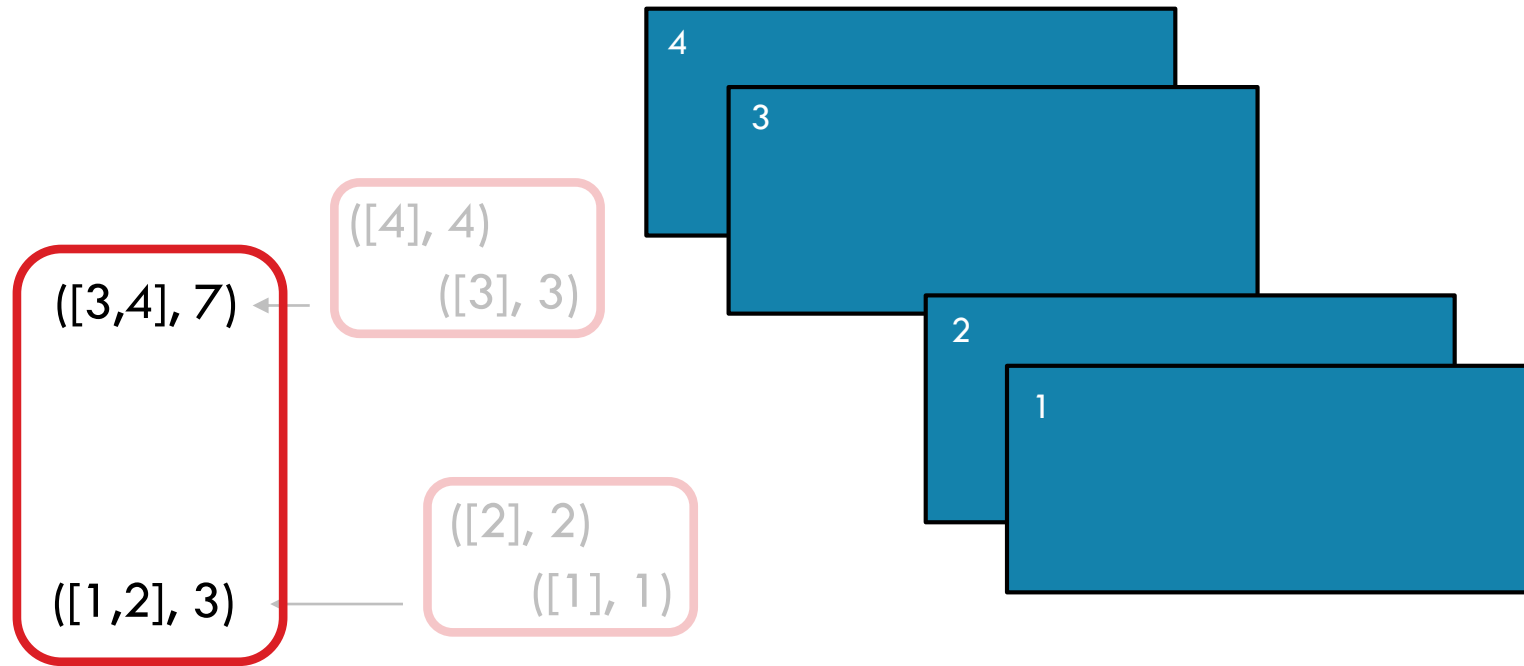
# AGGREGATE



# AGGREGATE



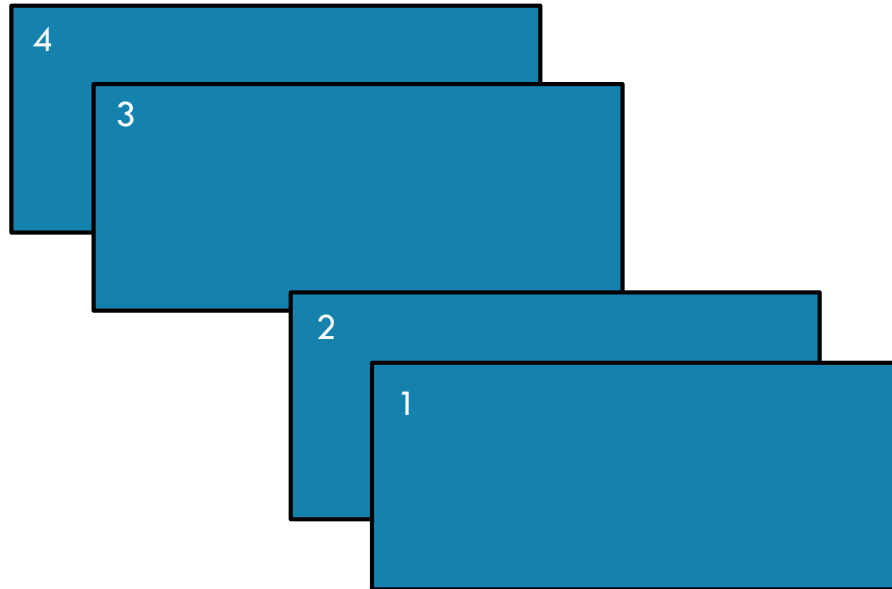
# AGGREGATE



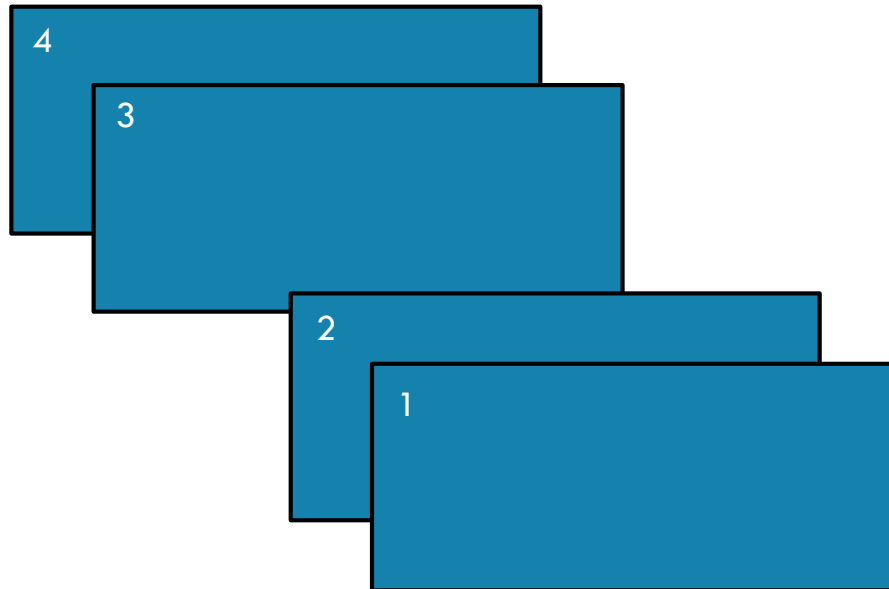
# AGGREGATE

$([3,4], 7)$

$([1,2], 3)$



# AGGREGATE



$([3,4], 7)$

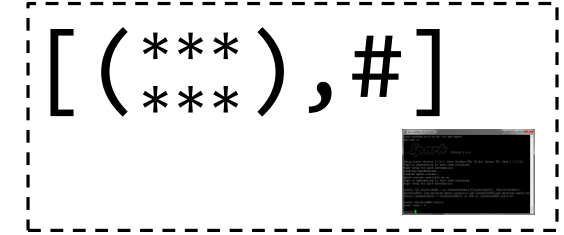
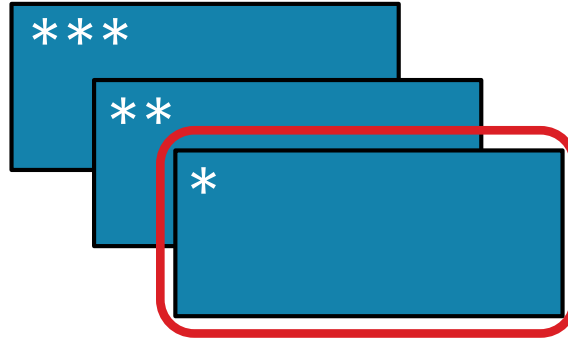
$([1,2], 3)$

$([1,2,3,4], 10) \leftarrow$

$([1,2,3,4], 10)$



# AGGREGATE



`aggregate(identity, seqOp, combOp)`

Aggregate all the elements of the RDD by:

- applying a user function to combine elements with user-supplied objects,
- then combining those user-defined results via a second user function,
- and finally returning a result to the driver.



```
seqOp = lambda data, item: (data[0] + [item], data[1] + item)
combOp = lambda d1, d2: (d1[0] + d2[0], d1[1] + d2[1])
```

```
x = sc.parallelize([1,2,3,4])
y = x.aggregate([], 0), seqOp, combOp)
print(y)
```



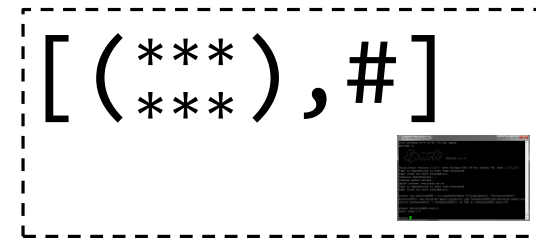
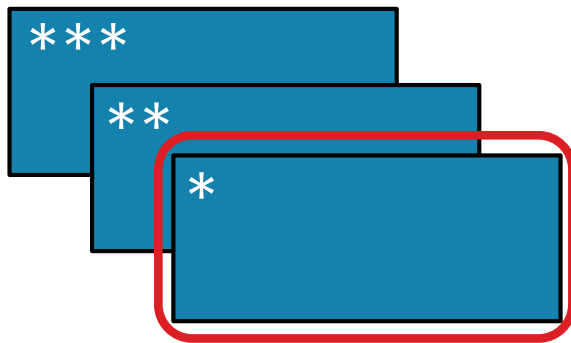
**x:** [1, 2, 3, 4]

**y:** ([1, 2, 3, 4], 10)





# AGGREGATE



`aggregate(identity, seqOp, combOp)`

Aggregate all the elements of the RDD by:

- applying a user function to combine elements with user-supplied objects,
- then combining those user-defined results via a second user function,
- and finally returning a result to the driver.

```
def seqOp = (data:(Array[Int], Int), item:Int) =>
  (data._1 :+ item, data._2 + item)

def combOp = (d1:(Array[Int], Int), d2:(Array[Int], Int)) =>
  (d1._1.union(d2._1), d1._2 + d2._2)

val x = sc.parallelize(Array(1,2,3,4))
val y = x.aggregate((Array[Int](), 0))(seqOp, combOp)

println(y)
```

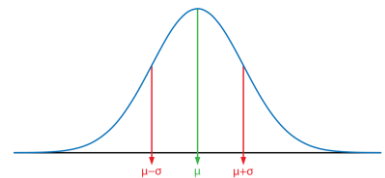
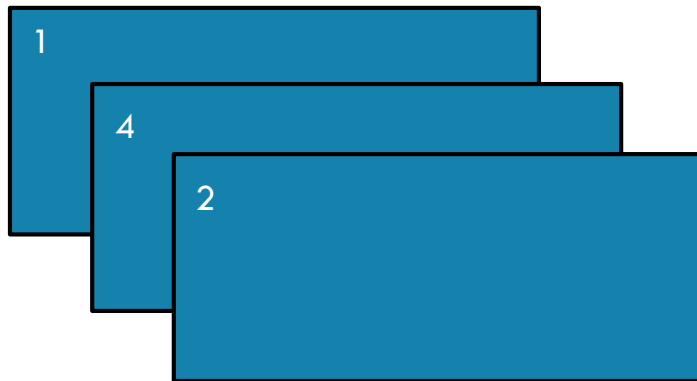


**x:** [1, 2, 3, 4]

**y:** (Array(3, 1, 2, 4),10)



# MAX



# MAX



`max()`

Return the maximum item in the RDD



```
x = sc.parallelize([2,4,1])  
y = x.max()  
  
print(x.collect())  
print(y)
```

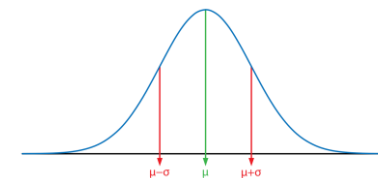


```
val x = sc.parallelize(Array(2,4,1))  
val y = x.max  
  
println(x.collect().mkString(", "))  
println(y)
```

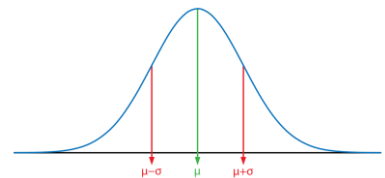
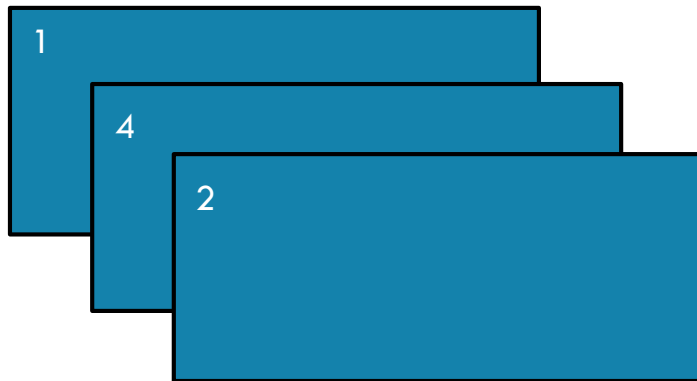


`x:` [2, 4, 1]

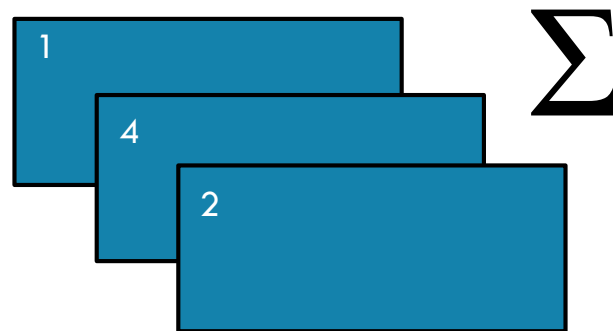
`y:` 4



# SUM



# SUM



`sum()`

Return the sum of the items in the RDD



```
x = sc.parallelize([2,4,1])
y = x.sum()

print(x.collect())
print(y)
```



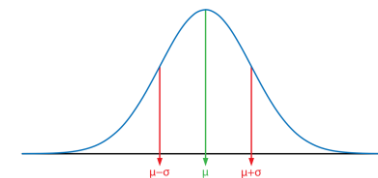
```
val x = sc.parallelize(Array(2,4,1))
val y = x.sum

println(x.collect().mkString(", "))
println(y)
```



`x:` [2, 4, 1]

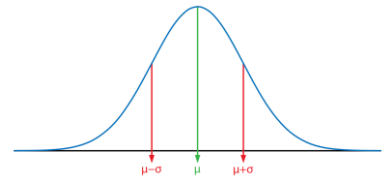
`y:` 7



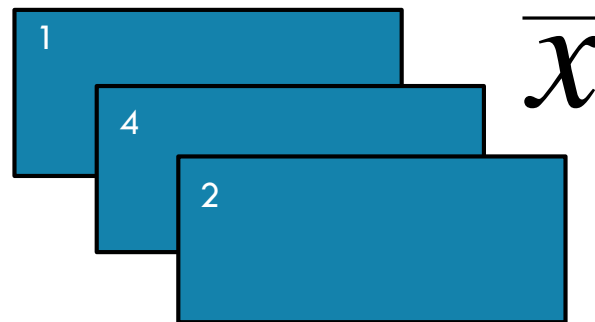
# MEAN



2.33333333



# MEAN



2.3333333

`mean()`

Return the mean of the items in the RDD



```
x = sc.parallelize([2,4,1])  
y = x.mean()  
  
print(x.collect())  
print(y)
```

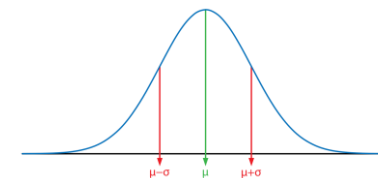


```
val x = sc.parallelize(Array(2,4,1))  
val y = x.mean  
  
println(x.collect().mkString(", "))  
println(y)
```

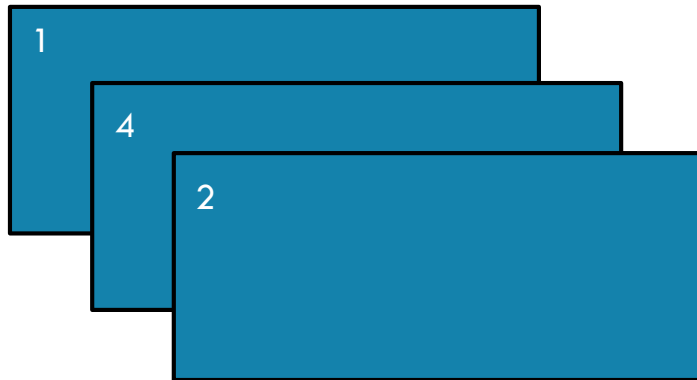


`x:` [2, 4, 1]

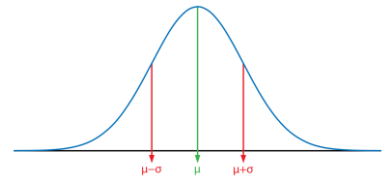
`y:` 2.3333333



# STDEV

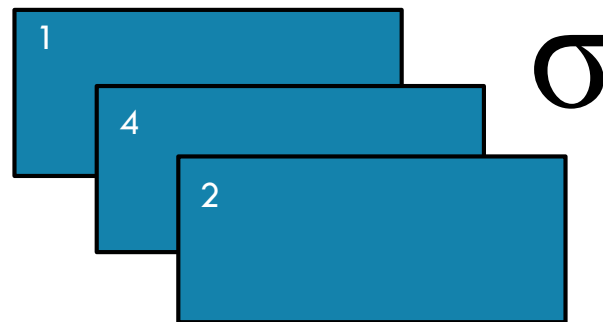


1.2472191





# STDEV



1.2472191

`stdev()`

Return the standard deviation of the items in the RDD



```
x = sc.parallelize([2,4,1])
y = x.stdev()

print(x.collect())
print(y)
```



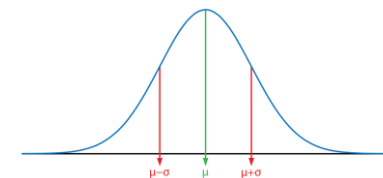
```
val x = sc.parallelize(Array(2,4,1))
val y = x.stdev

println(x.collect().mkString(", "))
println(y)
```

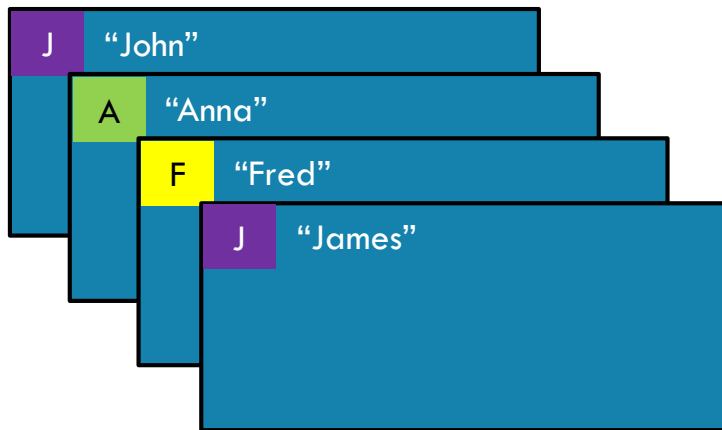


`x:` [2, 4, 1]

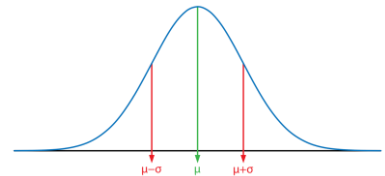
`y:` 1.2472191



# COUNTBYKEY



{'A': 1, 'J': 2, 'F': 1}



# COUNTBYKEY



`countByKey()`

Return a map of keys and counts of their occurrences in the RDD



```
x = sc.parallelize([('J', 'James'), ('F','Fred'),  
                  ('A','Anna'), ('J','John')])
```

```
y = x.countByKey()  
print(y)
```



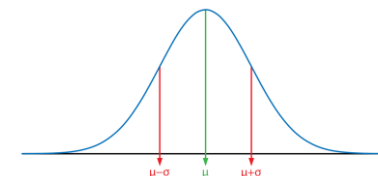
**x:** `[('J', 'James'), ('F','Fred'),  
 ('A','Anna'), ('J','John')]`

**y:** `{'A': 1, 'J': 2, 'F': 1}`

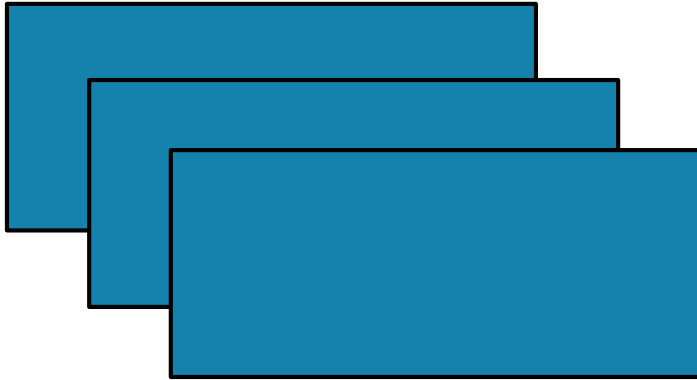


```
val x = sc.parallelize(Array(('J',"James"),('F',"Fred"),  
                           ('A',"Anna"),('J',"John")))
```

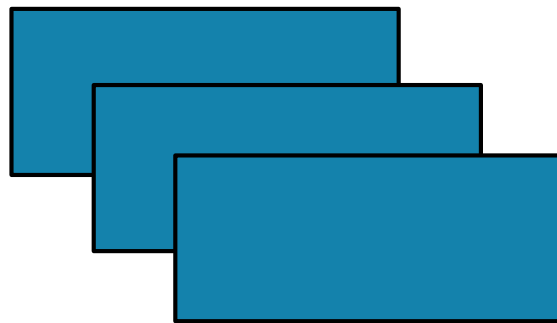
```
val y = x.countByKey()  
println(y)
```



# SAVEASTEXTFILE



# SAVEASTEXTFILE



`saveAsTextFile(path, compressionCodecClass=None)`

Save the RDD to the filesystem indicated in the path



```
dbutils.fs.rm("/temp/demo", True)
x = sc.parallelize([2,4,1])
x.saveAsTextFile("/temp/demo")
```

```
y = sc.textFile("/temp/demo")
print(y.collect())
```



```
dbutils.fs.rm("/temp/demo", true)
val x = sc.parallelize(Array(2,4,1))
x.saveAsTextFile("/temp/demo")
```

```
val y = sc.textFile("/temp/demo")
println(y.collect().mkString(", "))
```



`x:` [2, 4, 1]

`y:` [u'2', u'4', u'1']

