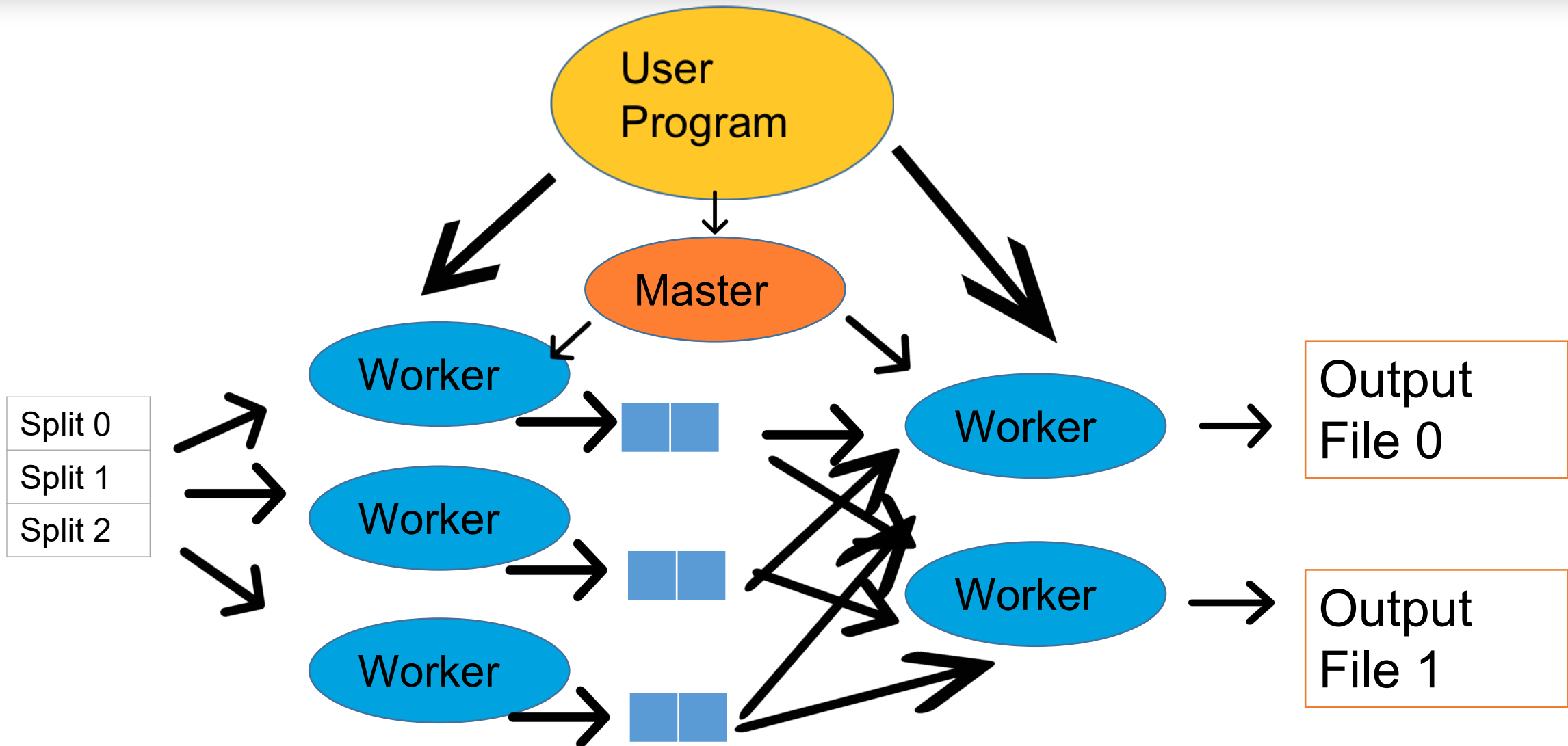




Big Data Tools

Data Management in MapReduce Systems



HDFS



- | Files split into 128MB blocks

- | Blocks replicated across several DataNodes

- | NameNode stores metadata

- | Optimized for large files, sequential reads

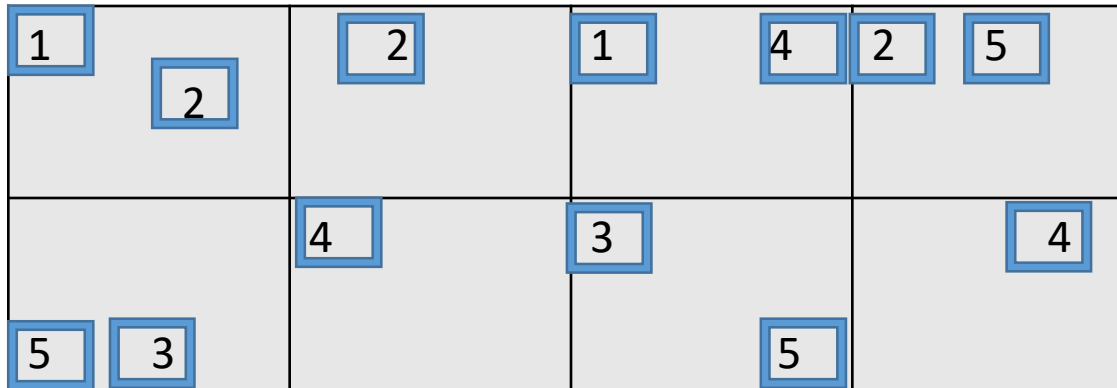
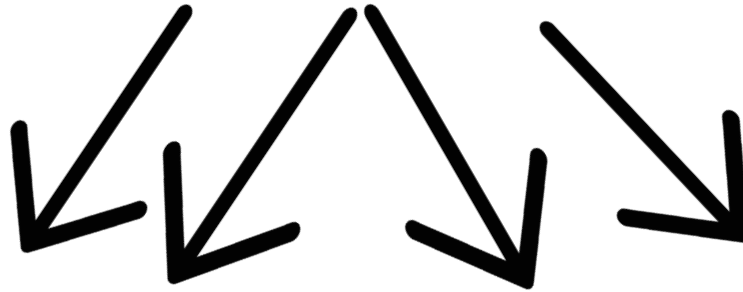
- | Files are append-only

Namenode(Filename, numReplicas, block-ids,...)

/users/sameerp/data/part-0,r:2,{1,3}...

/users/sameerp/data/part-1,r:3,{2,4,5}...

Centralized namenode



Many datanode

MapReduce Systems: How it Works



| Distributed file system (HDFS)

- Single namespace for entire cluster
- Replicates data 3x for fault-tolerance

| MapReduce Framework

- Executes user jobs specified as “map” and “reduce” functions
- Manages work distribution & fault-tolerance

MapReduce Execution Details



| Mappers preferentially placed on same node or same rack as their input block

- Push computation to data, minimize network use

| Mappers save outputs to local disk before serving to reducers

- Allows having more reducers than nodes
- Allows recovery if a reducer crashes

Fault Tolerance in Hadoop



| If a task crashes:

- Retry on another node
- OK for a map because it had no dependencies
- OK for reduce because map outputs are on disk

| If the same task repeatedly fails, fail the job

| If a node crashes:

- Re-launch its current tasks on other nodes
- Re-launch any maps the node previously ran
 - Necessary because their output files were lost along with the crashed node

MapReduce Programming Model



| Data type

- key-value records

| Map function:

- (Key1, Value1) →
list(Key2, Value2)

| Reduce function:

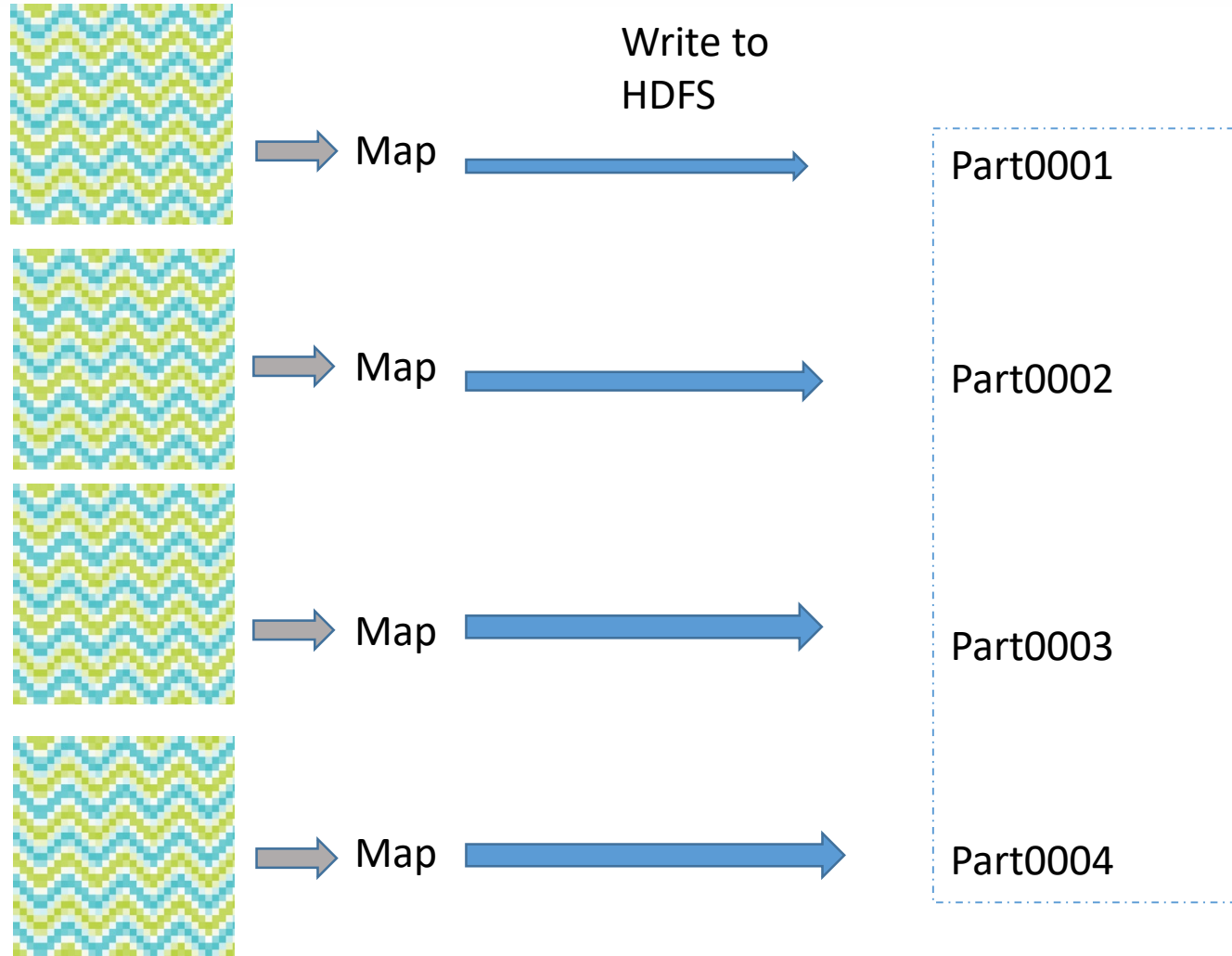
- (Key2, list(Value2))
→ list(Key3, Value3)

Select Operator in MapReduce

$\sigma_{rating > 8}(S2)$

Sid	Sname	Rating	age
28	Yuppy	9	35.0
31	Lubber	8	55.5
44	Guppy	5	35.0
58	Rusty	10	35.0

Example: Color Filter: Blue and Green



Projection Operator in MapReduce

$\pi_{sname, rating}(S2)$

sname	rating
yuppy	9
lubber	8
guppy	5
rusty	10

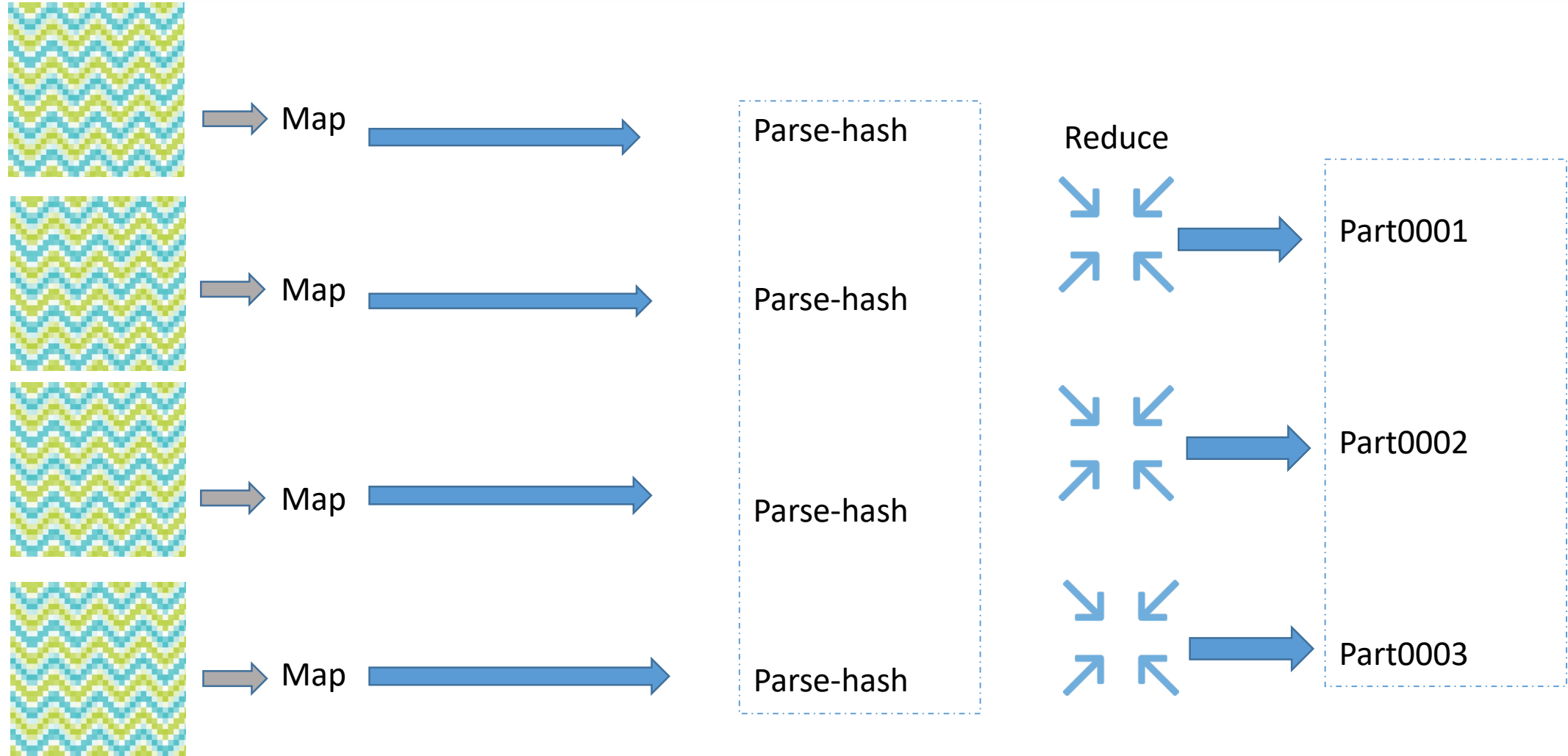
sid	sname	rating
28	yuppy	9
31	lubber	8
44	guppy	5
58	rusty	10

Sorting Operator in MapReduce



sid	sname	rating	age
28	yuppy	9	35.0
31	lubber	8	55.5
44	guppy	5	35.0
58	rusty	10	35.0

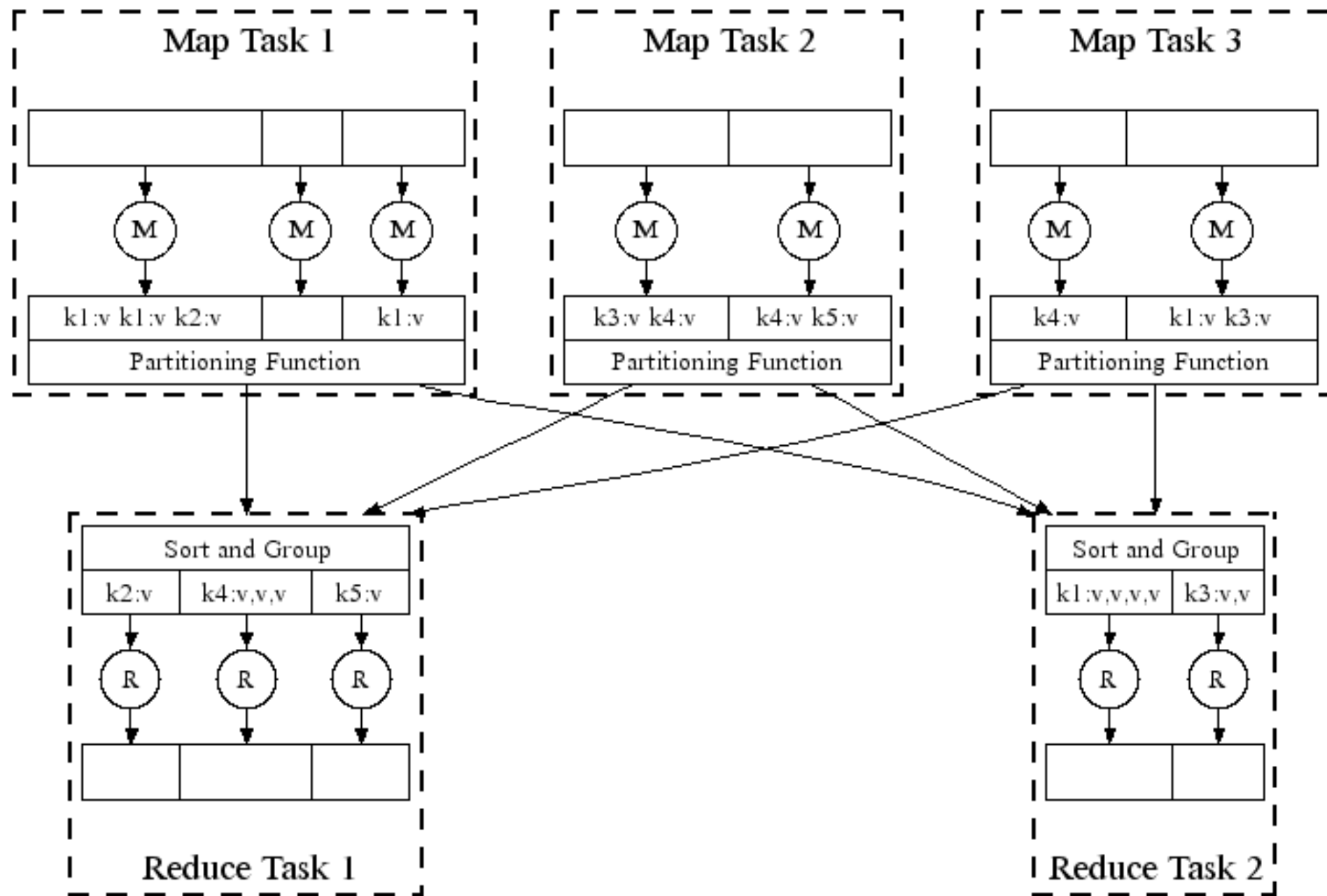
Group By Example: Count the number of each color in a data set



Join Operator in MapReduce

sid	bid	day
22	101	10/10/96
58	103	11/12/96

sid	sname	rating	age
28	yuppy	9	35.0
31	lubber	8	55.5
44	guppy	5	35.0
58	rusty	10	35.0



Input>Splitting>Mapping>Shuffling
>Reducing>Final Results

