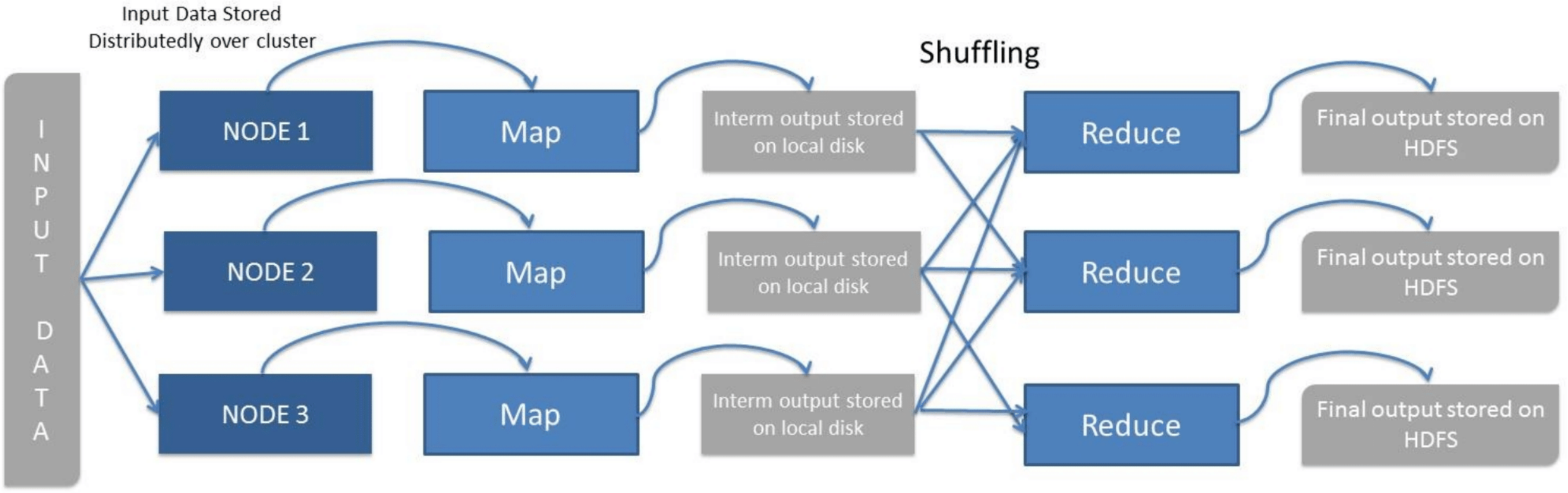
Advanced MapReduce Concepts

Agenda

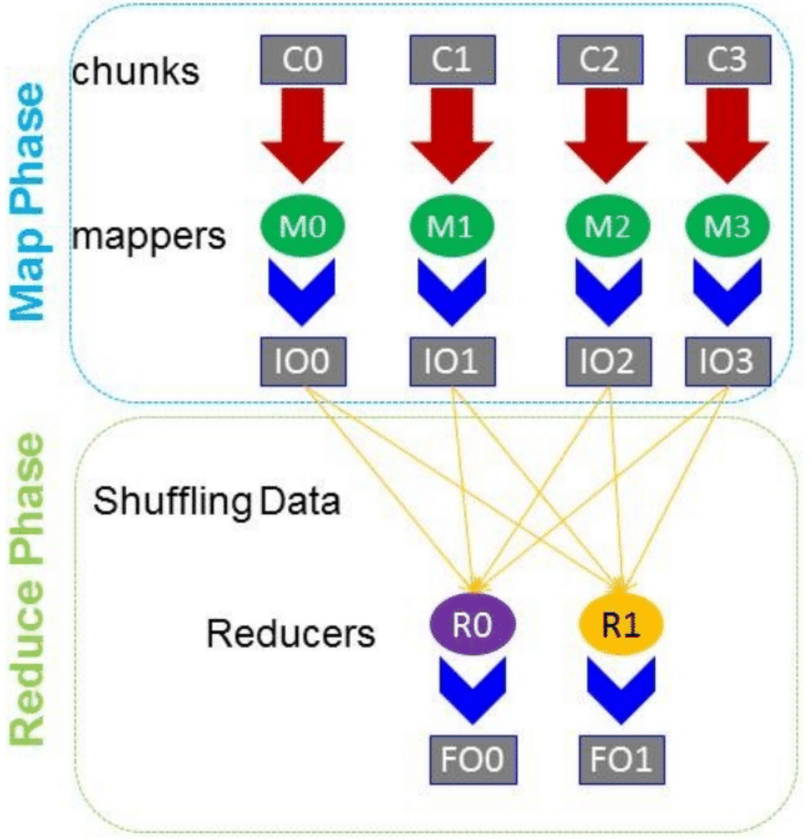
- ✓ Anatomy of MapReduce
- ✓ Hadoop data types
- ✓ Map Reduce – A closer look
- ✓ Map Reduce Components
- ✓ Map Reduce in a Nut-Shell

Anatomy of MapReduce



Anatomy of MapReduce

- In MapReduce, chunks are processed in isolation by tasks called *Mappers*
- The outputs from the mappers are denoted as *intermediate outputs* (IOs)
- The process of bringing together IOs into a set of Reducers is known as *Shuffling and Sort process*
- Intermediate outputs will be given as input into second set of tasks called *Reducers*
- The Reducers produce the *final outputs* (FOs)
- Overall, *MapReduce* breaks the data flow into two phases, map phase and reduce phase



Hadoop DataTypes

- MR has a defined way of keys and values types for it to move across cluster:
  - Values → Writable
  - Keys → WritableComparable<T>
  - WritableComparable = Writable+Comparable<T>

Java type	Hadoop type
Boolean	BooleanWritable
Byte	ByteWritable
Double	DoubleWritable
Integer	IntWritable
Long	LongWritable
String	Text
null	NullWritable

Custom Hadoop DataTypes

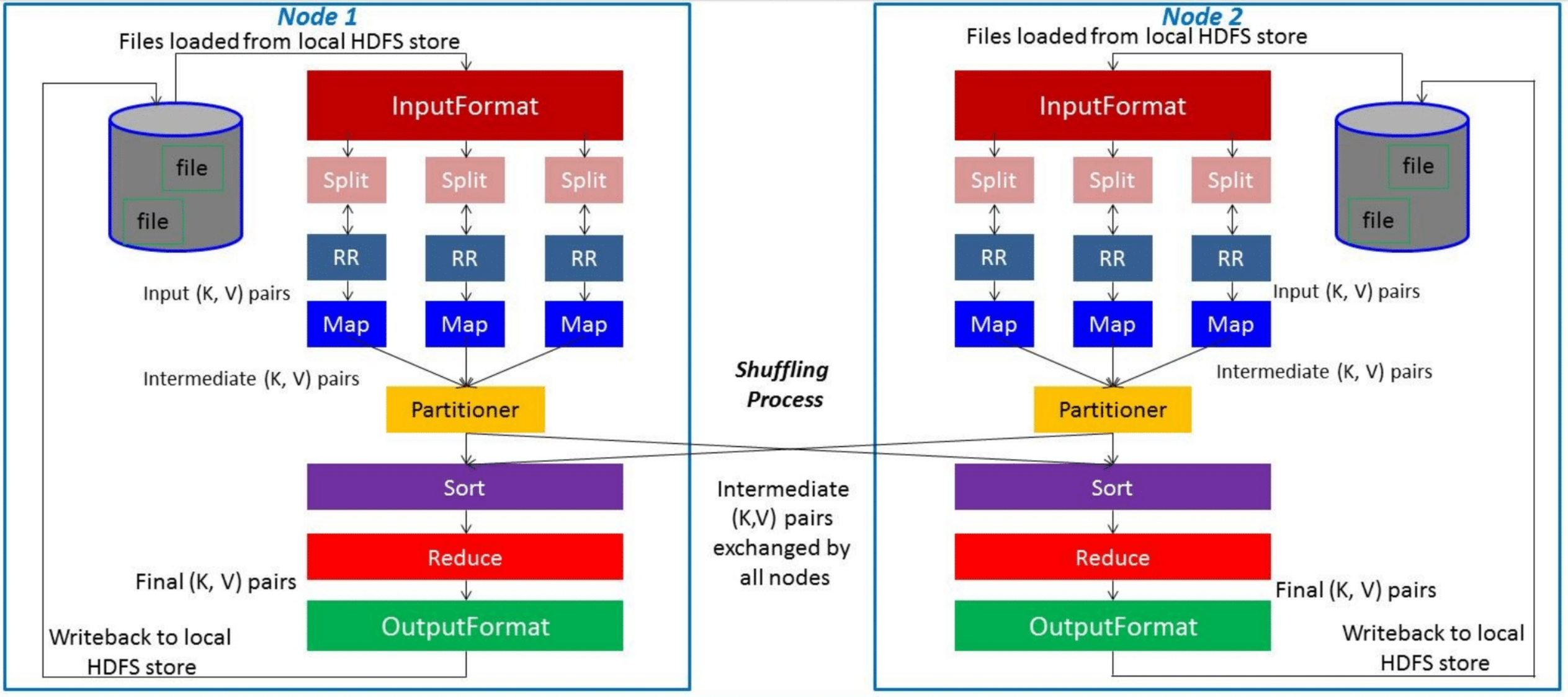
For any class to be value, it has to implement

- org.apache.hadoop.io.Writable
  - write(DataOutput out)
  - readFields(DataInput in)

For any class to be key, it has to implement

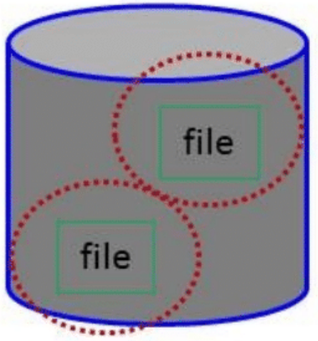
- org.apache.hadoop.io.WritableComparable<T>
  - write(DataOutput out)
  - readFields(DataInput in)
  - compareTo(T o)

MapReduce – A Closer Look

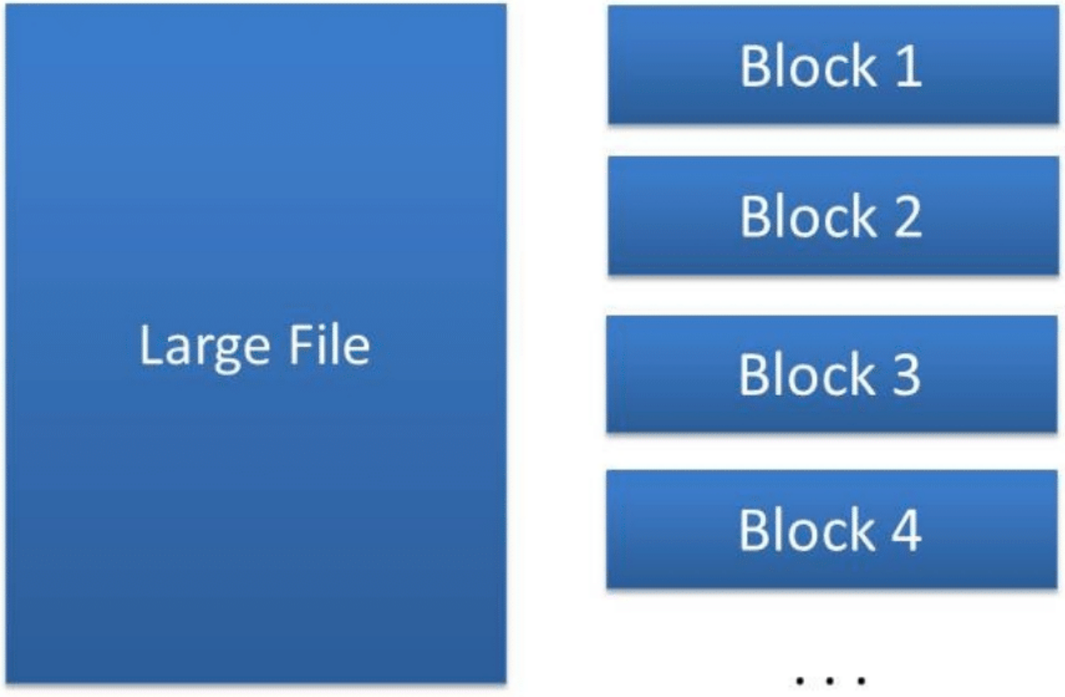


Input Files

- Input files are where the data for a MapReduce task is initially stored
- The input files typically reside in a distributed file system (e.g. HDFS)
- The format of input files is arbitrary
  - Line-based log files
  - Binary files
  - Multi-line input records
  - Or something else entirely



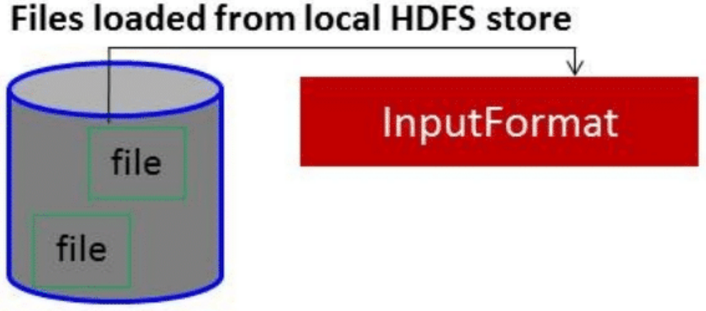
HDFS Blocks



- Big File is divided into multiple blocks and stored in hdfs.
- This is a physical division of data
- dfs.block.size (128MB default size)

InputFormat

- How the input files are split up and read is defined by the *InputFormat*
- InputFormat is a class that does the following:
  - Select the files that should be used for input
  - Defines the *InputSplits* that break a file
  - Provides a factory for *RecordReader* objects that read the file



InputFormat (Contd..)

- An InputFormat is responsible for creating the input splits and dividing them into records.
- How we get the data to mapper

```
public abstract class InputFormat<K, V> {
    public abstract List<InputSplit> getSplits(JobContext context)
    throws IOException, InterruptedException;

    public abstract RecordReader<K, V>
    createRecordReader(InputSplit split,
    TaskAttemptContext context) throws IOException,
    InterruptedException;
}
```

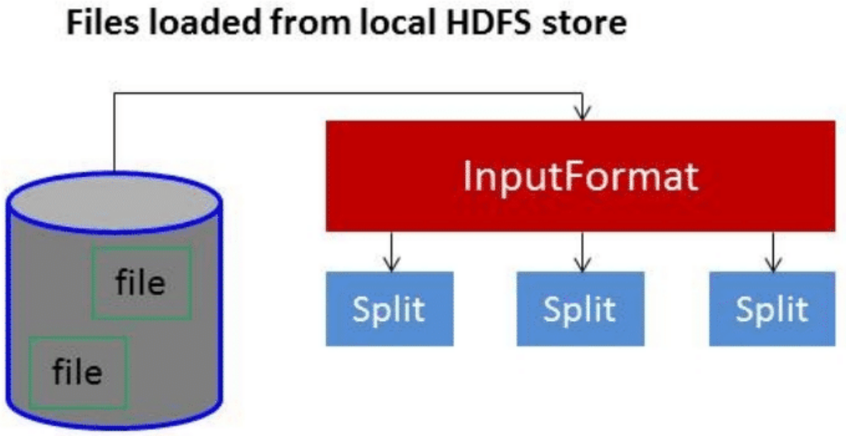
InputFormat Types

The Hadoop framework provides a large variety of input formats:

- **TextInputFormant:** The key is the byte offset, and the value is the line.
- **KeyValueInputFormat:** Key upto first tab char, rest is the value
- **NLineInputFormat:** Similar to TextInputFormat, but it provides n lines of input.
- **MultiFileInputFormat:** An abstract class that lets the user implement an input format that aggregates multiple files into one split.
- **SequenceFIleInputFormat:** The input file is a Hadoop sequence file, containing serialized key/value pairs.

InputSplit

- An *input split* describes a unit of work that comprises a single map task in a MapReduce program
- By default, the InputFormat breaks a file up into 64MB splits
- By dividing the file into splits, it allows several map tasks to operate on a single file in parallel
- If the file is very large, this can improve performance significantly through parallelism
- Each map task corresponds to a *single* input split



InputSplits and Records

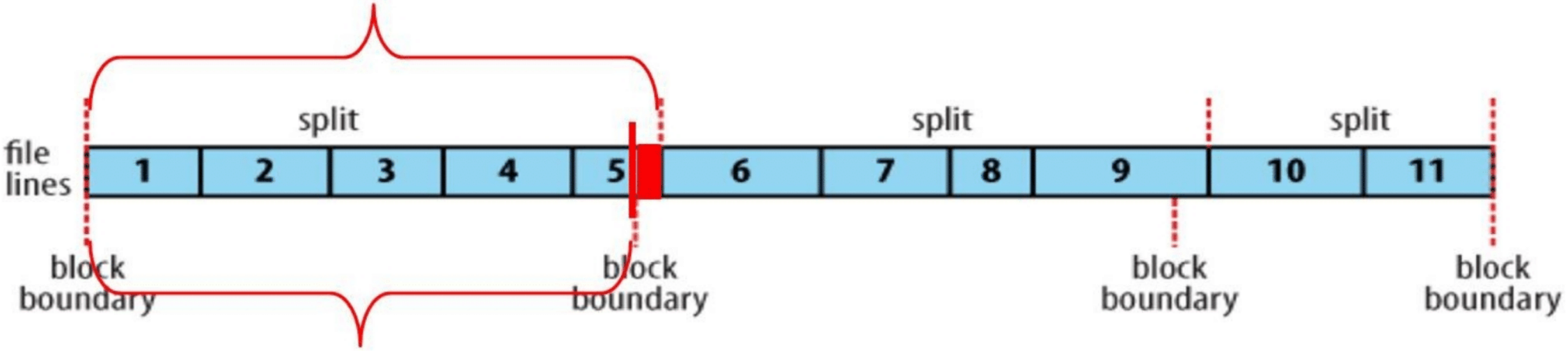
Input split

- A chunk of data processed by a mapper
- Further divided into records
- Map process these records
  - Record = key + value
- How to correlate to a DB table
  - Group of rows ➔ split
  - Row ➔ record

Key	Value
R1	R1
R2	R2
R3	R3

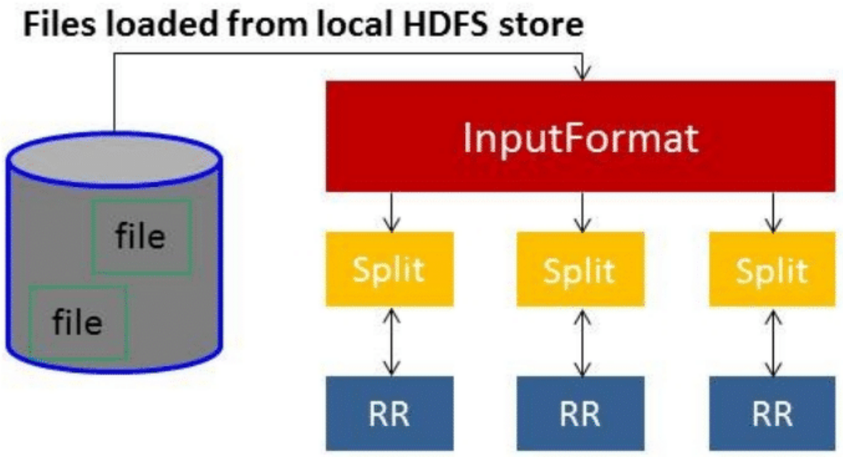
InputSplit and HDFS blocks

- Split gives logical record boundaries
- Blocks – physical boundaries (size)
- Even in data locality some remote reading is done, a slight overhead.



RecordReader

- The input split defines a slice of work but does not describe how to access it
- The *RecordReader* class actually loads data from its source and converts it into (K, V) pairs suitable for reading by Mappers
- The RecordReader is invoked repeatedly on the input until the entire split is consumed
- Each invocation of the RecordReader leads to another call of the map function defined by the programmer



Partitioner

- Each mapper may emit (K, V) pairs to *any* partition
- Therefore, the map nodes must all agree on where to send different pieces of intermediate data
- The *partitioner* class determines which partition a given (K,V) pair will go to
- The default partitioner computes *a hash value* for a given key and assigns it to a partition based on this result