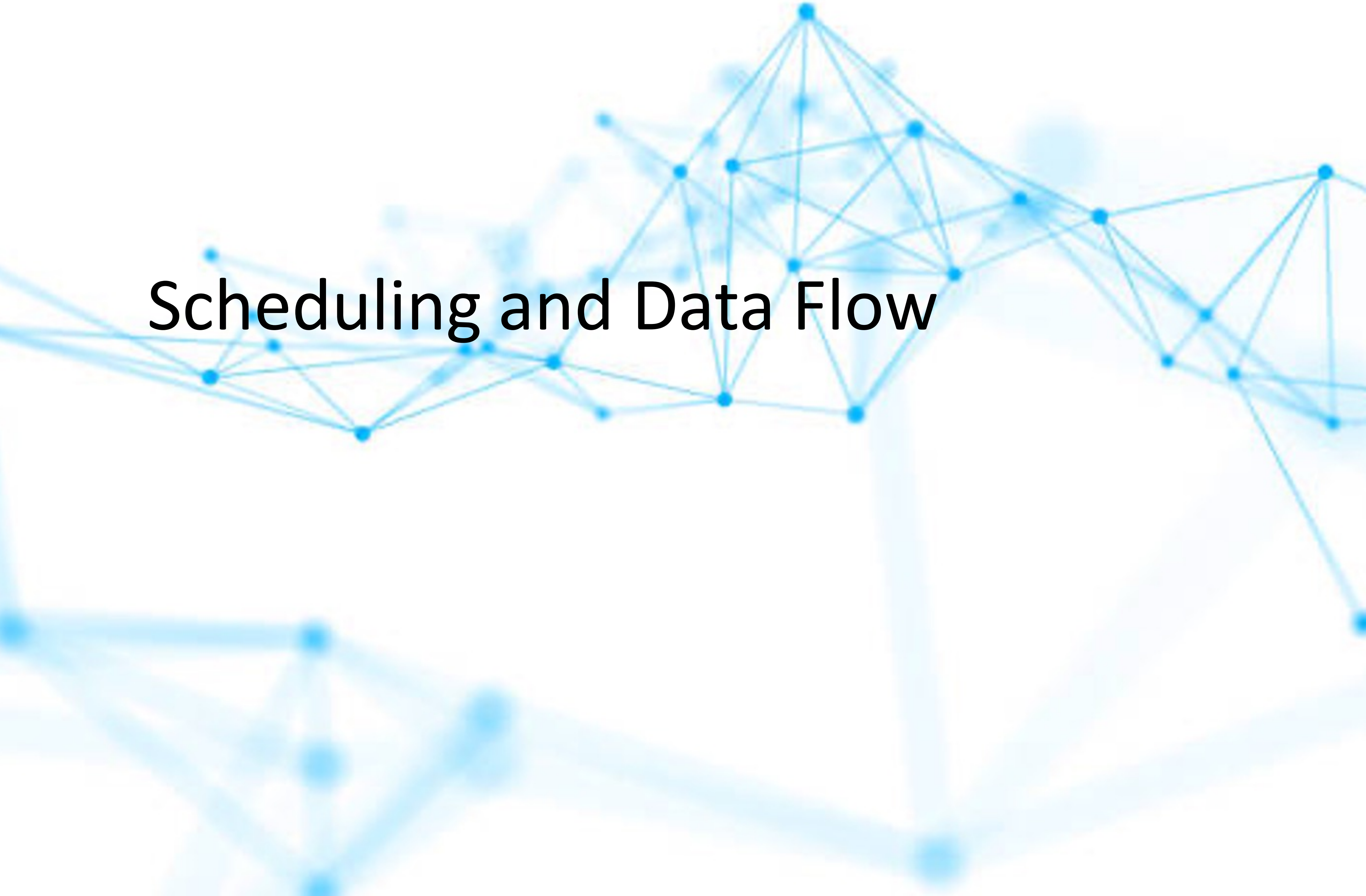
Scheduling and Data Flow

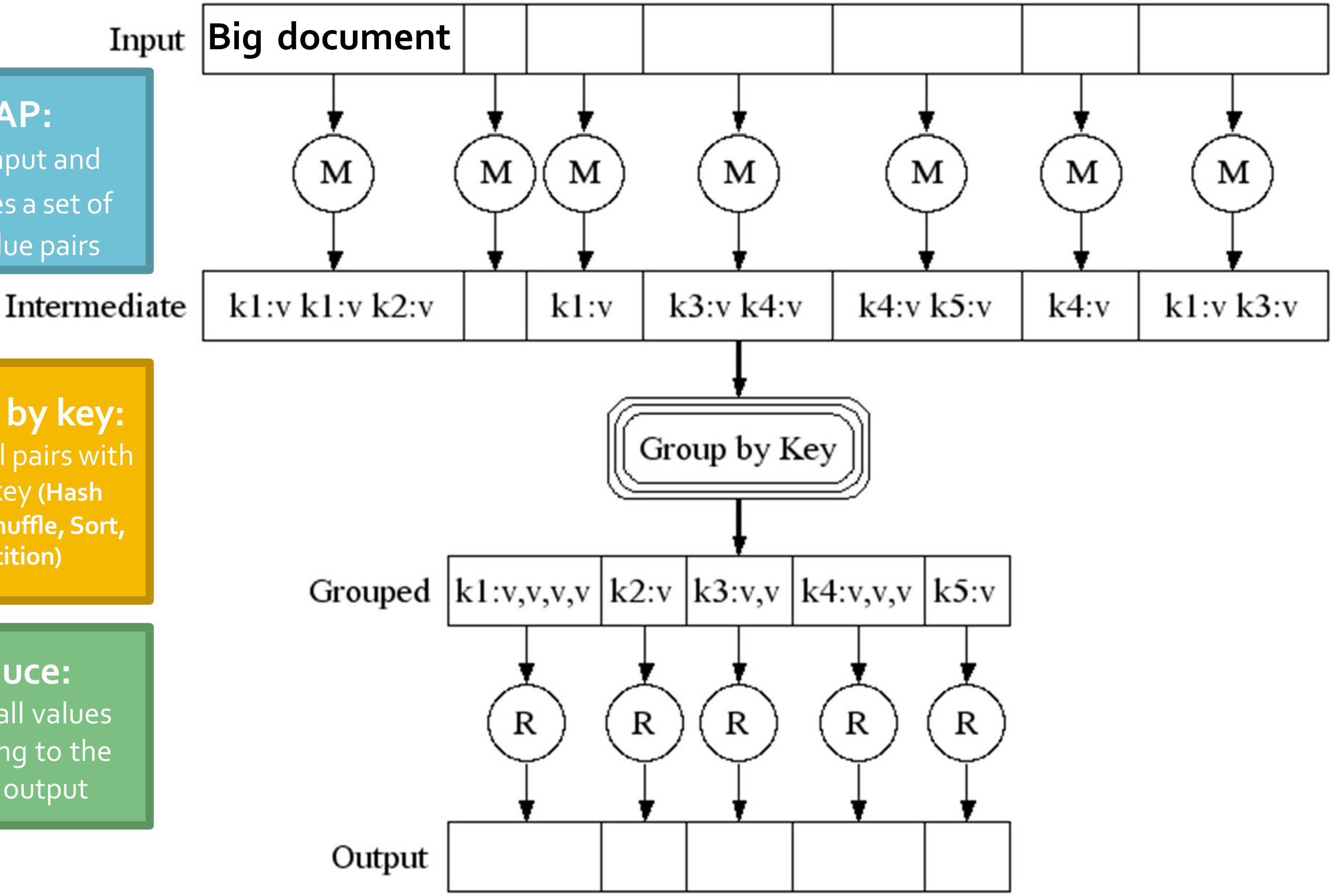


Map-Reduce: A diagram

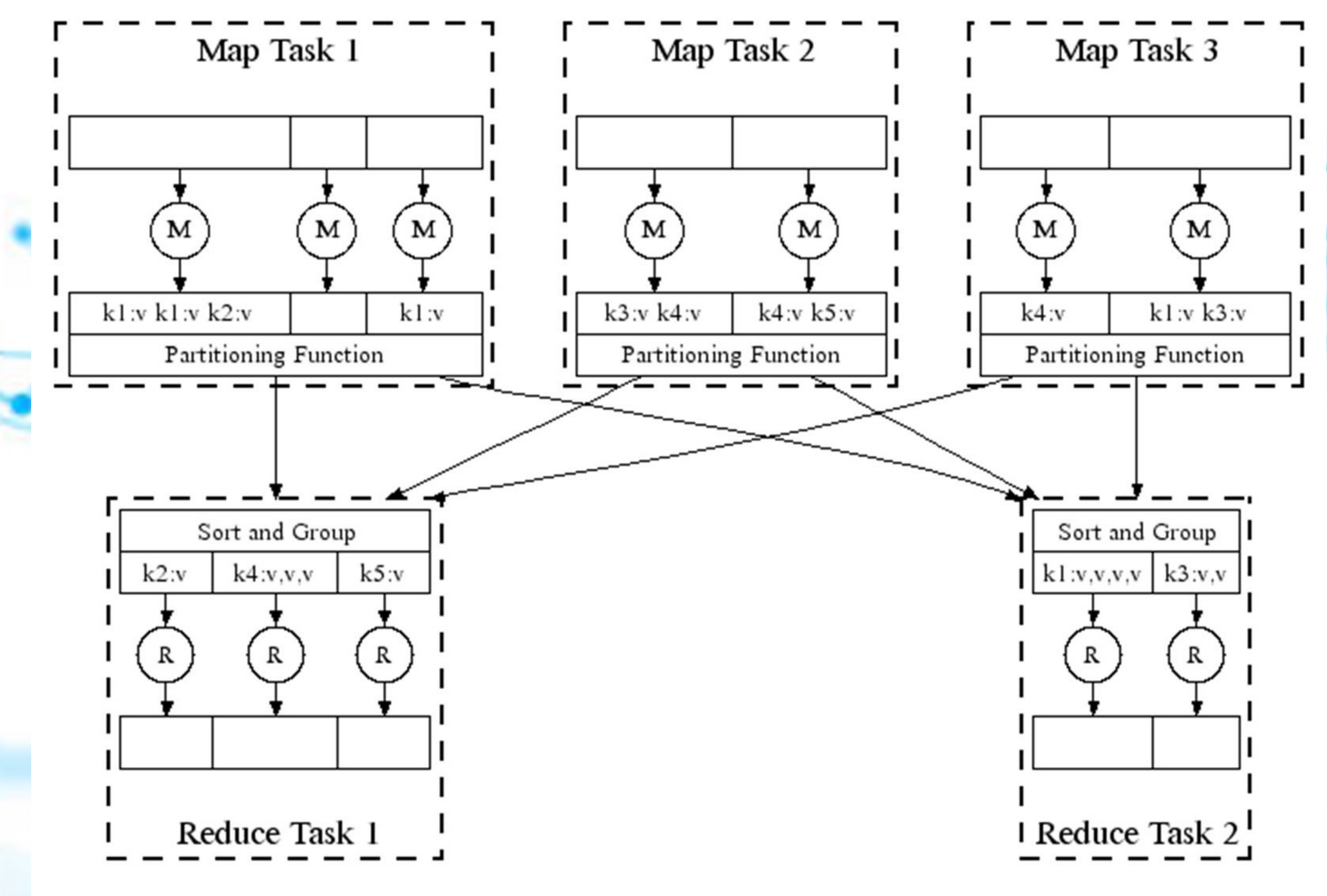
MAP:
Read input and produces a set of key-value pairs

Group by key:
Collect all pairs with same key **(Hash merge, Shuffle, Sort, Partition)**

Reduce:
Collect all values belonging to the key and output



Map-Reduce: In Parallel



All phases are distributed with many tasks doing the work

Map-Reduce: Environment

Map-Reduce environment takes care of:

- Partitioning the input data
- Scheduling the program’s execution across a set of machines
- Performing the **group by key** step
- Handling node failures
- Managing required inter-machine communication

Data Flow

- Input and final output are stored on the distributed file system (DFS):
  - Scheduler tries to schedule map tasks “close” to physical storage location of input data
- Intermediate results are stored on local FS of Map and Reduce workers
- Output is often input to another MapReduce task

Coordination: Master

- Master node takes care of coordination:
  - **Task status:** (idle, in-progress, completed)
  - **Idle tasks** get scheduled as workers become available
  - When a map task completes, it sends the master the location and sizes of its *R* intermediate files, one for each reducer
  - Master pushes this info to reducers
- Master pings workers periodically to detect failures

Dealing with Failures

- ○ **Map worker failure**
  - Map tasks completed or in-progress all worker are reset to idle
  - Idle tasks eventually rescheduled on other worker(s)
- ○ **Reduce worker failure**
  - Only in-progress tasks are reset to idle
  - Idle Reduce tasks restarted on other worker(s)
- ○ **Master failure**
  - MapReduce task is aborted and client is notified

How many Map and Reduce jobs?

- *M* map tasks, *R* reduce tasks
- **Rule of thumb:**
  - Make *M* much larger than the number of nodes in the cluster
  - One DFS chunk per map is common
  - Improves dynamic load balancing and speeds up recovery from worker failures
- **Usually *R* is smaller than *M***
  - Because output is spread across *R* files