Large-Scale Parallel Computing

Aamer Shah

shah@cs.tu-darmstadt.de

EXERCISE 2

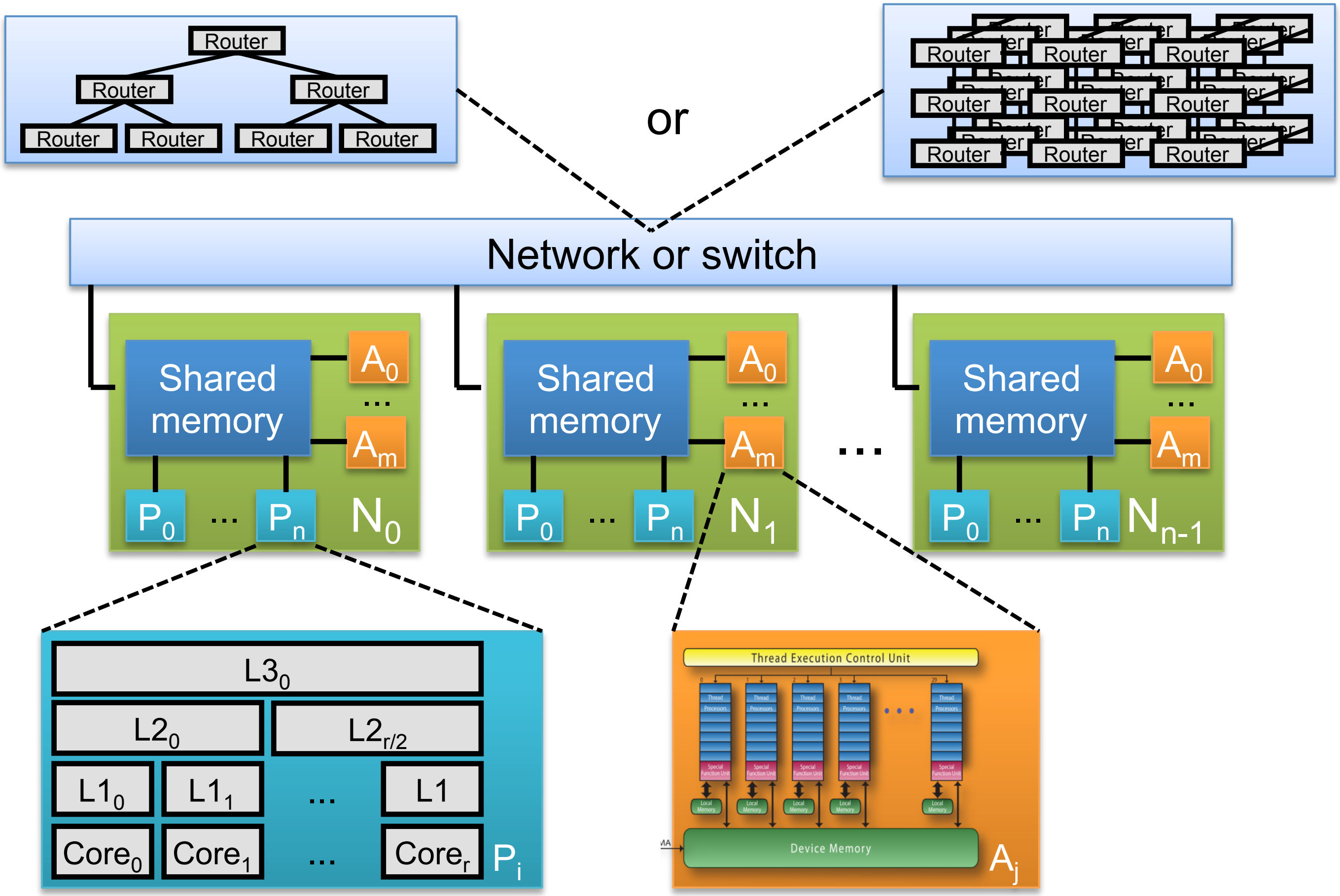
Aim of exercise

- To understand the problem

➢ How do you develop a program on a distributed memory system?

- When the problem is understood, the answer can be appreciated
  - Less emphasis on network socket programming
  - More on **distributed memory** programming and design issues

Typical supercomputer architecture



Distributed memory system

- No sharing of data between compute nodes
- How do you exchange data and synchronize between processes?
- Processes send messages to each other

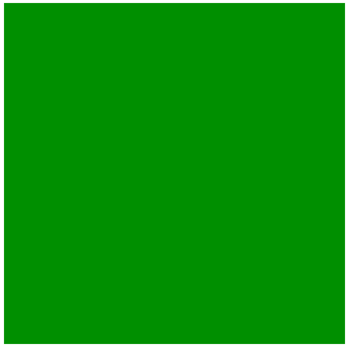
- The MPI library provides easy set of functions for message passing
- BUT lets see what kind of functions should the MPI library provide

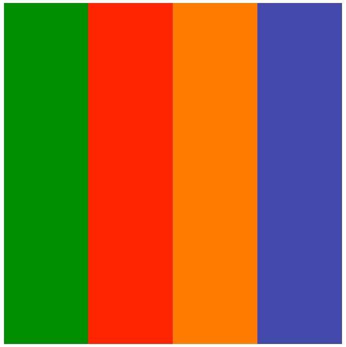
TASK 1

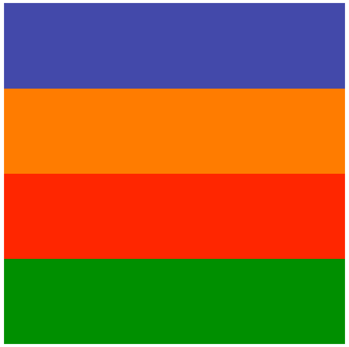
Task 1

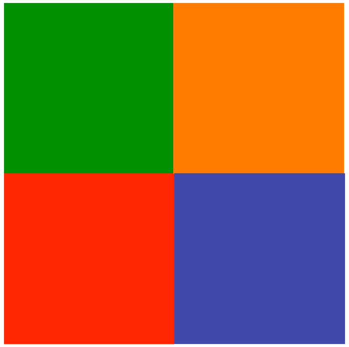
- Matrix addition with master and workers

- Work load distribution possibilities:
  - Distribute rows
  - Distribute columns
  - Distribute tiles
  - Many more possibilities





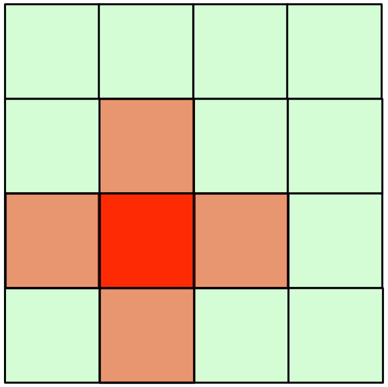




TASK 2

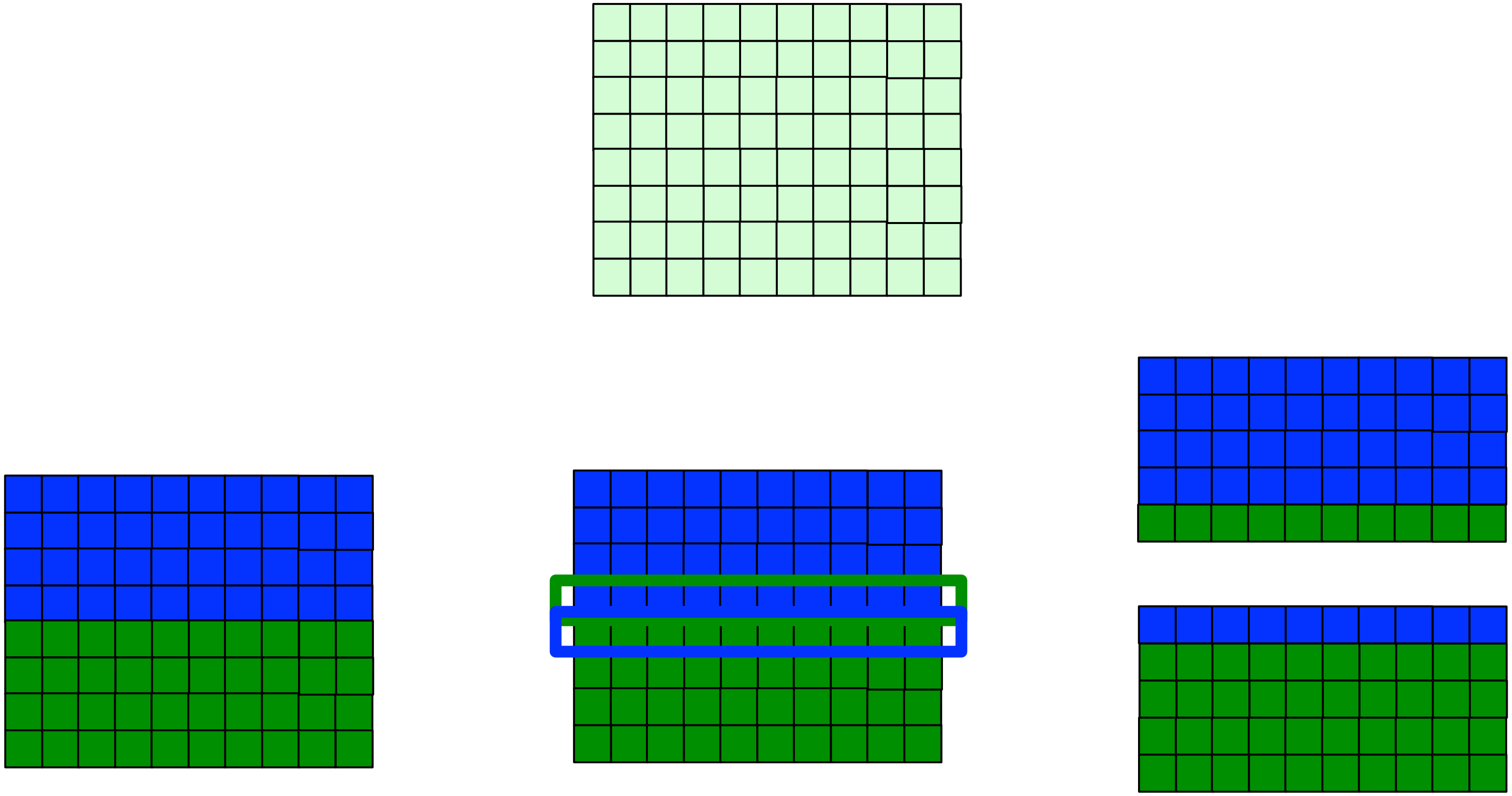
Task 2

- Median filter

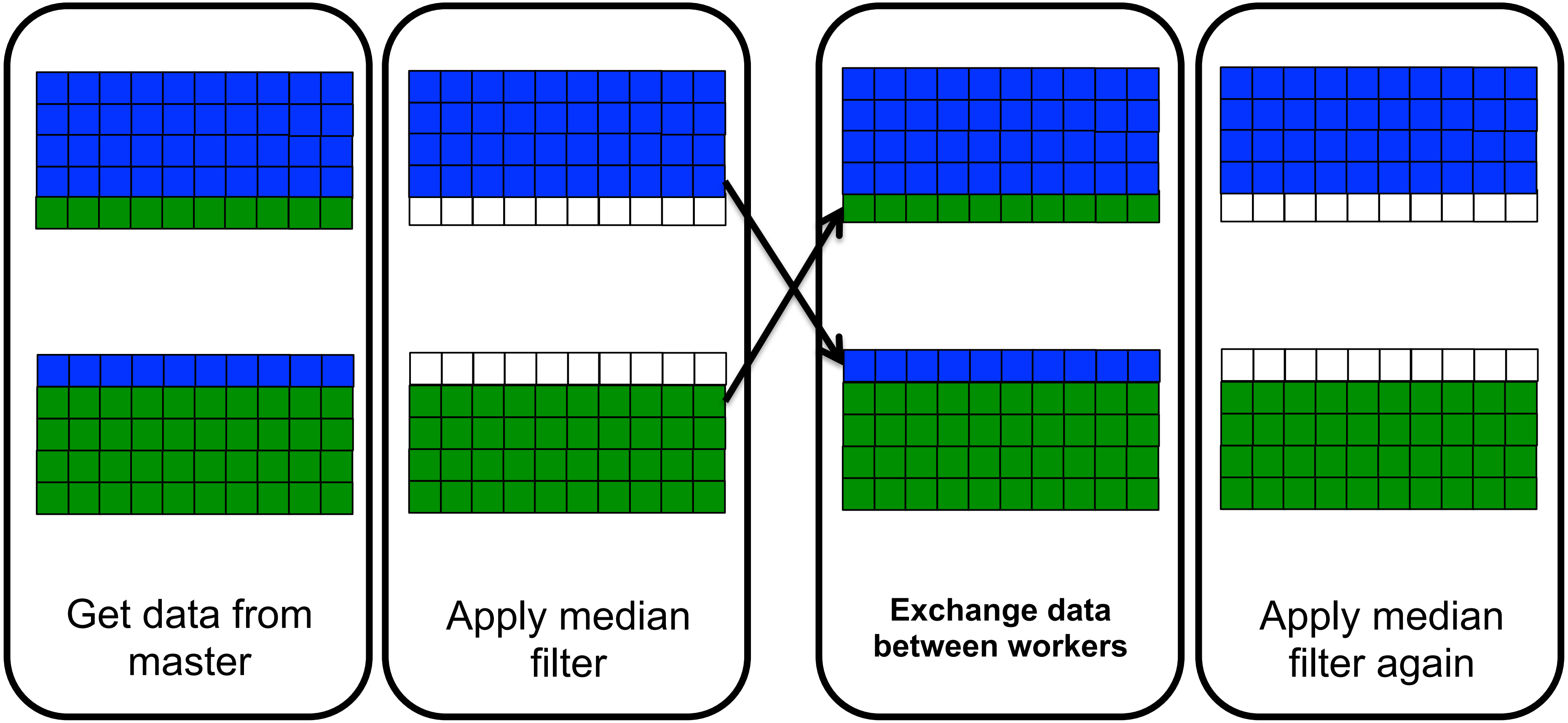


Task 2

- Median filter



Task 2 – executing the filter twice?



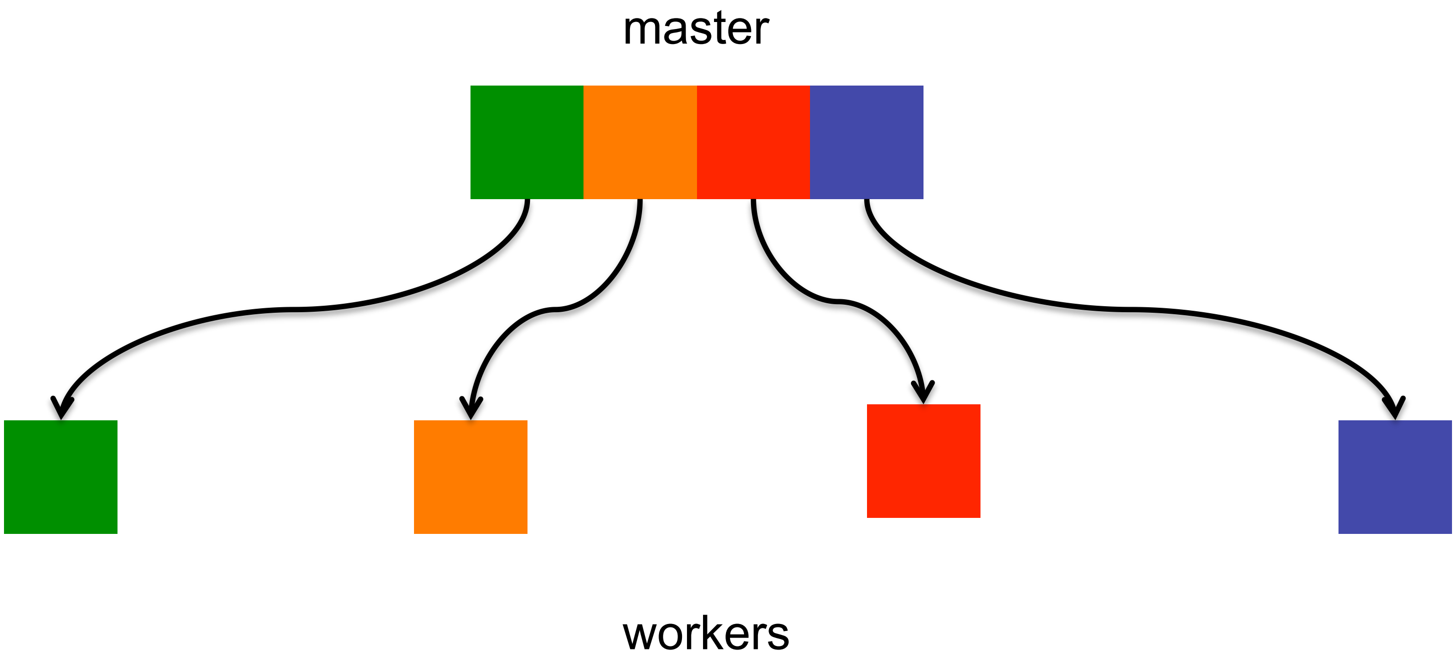
TASK 3

Task 3

- Message passing utility library – useful functions
- What kind of message passing did we perform in our tasks?

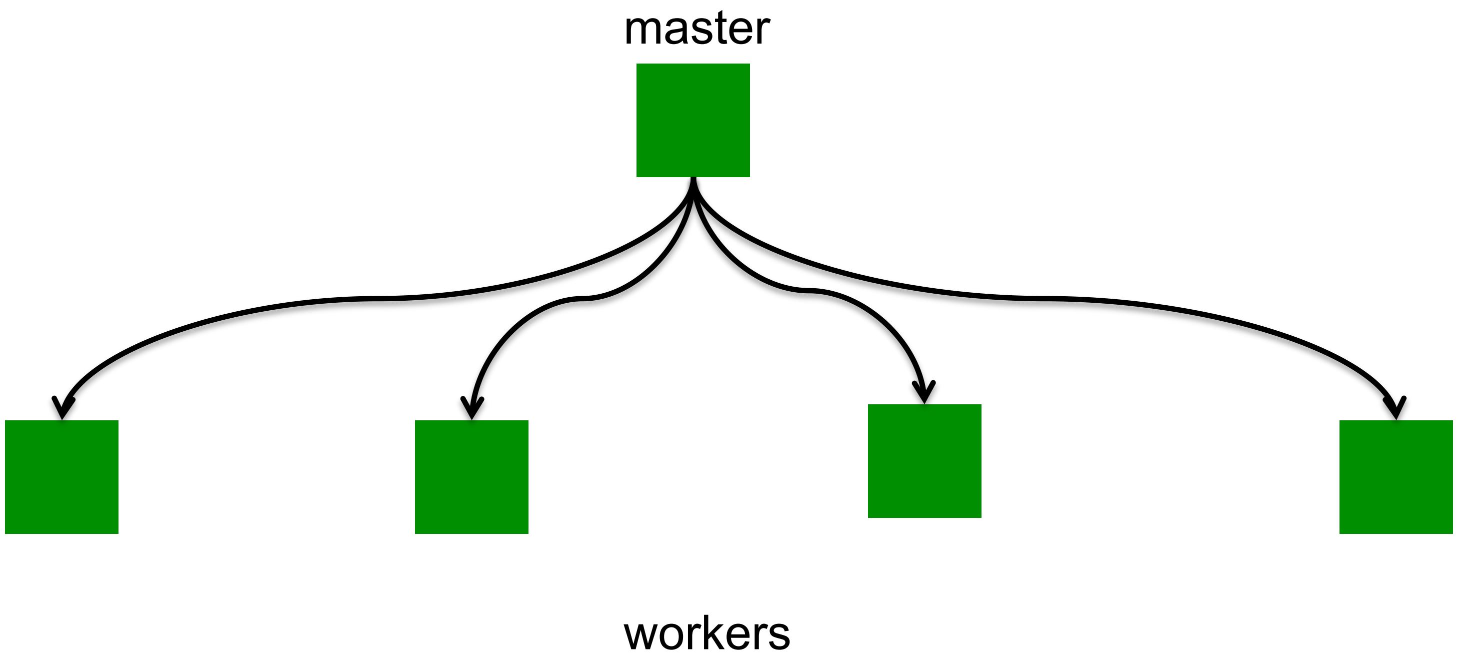
Task 3 – scatter operation

- Distribution of IDs by master
  - Scatter an array among workers (master also gets a value)



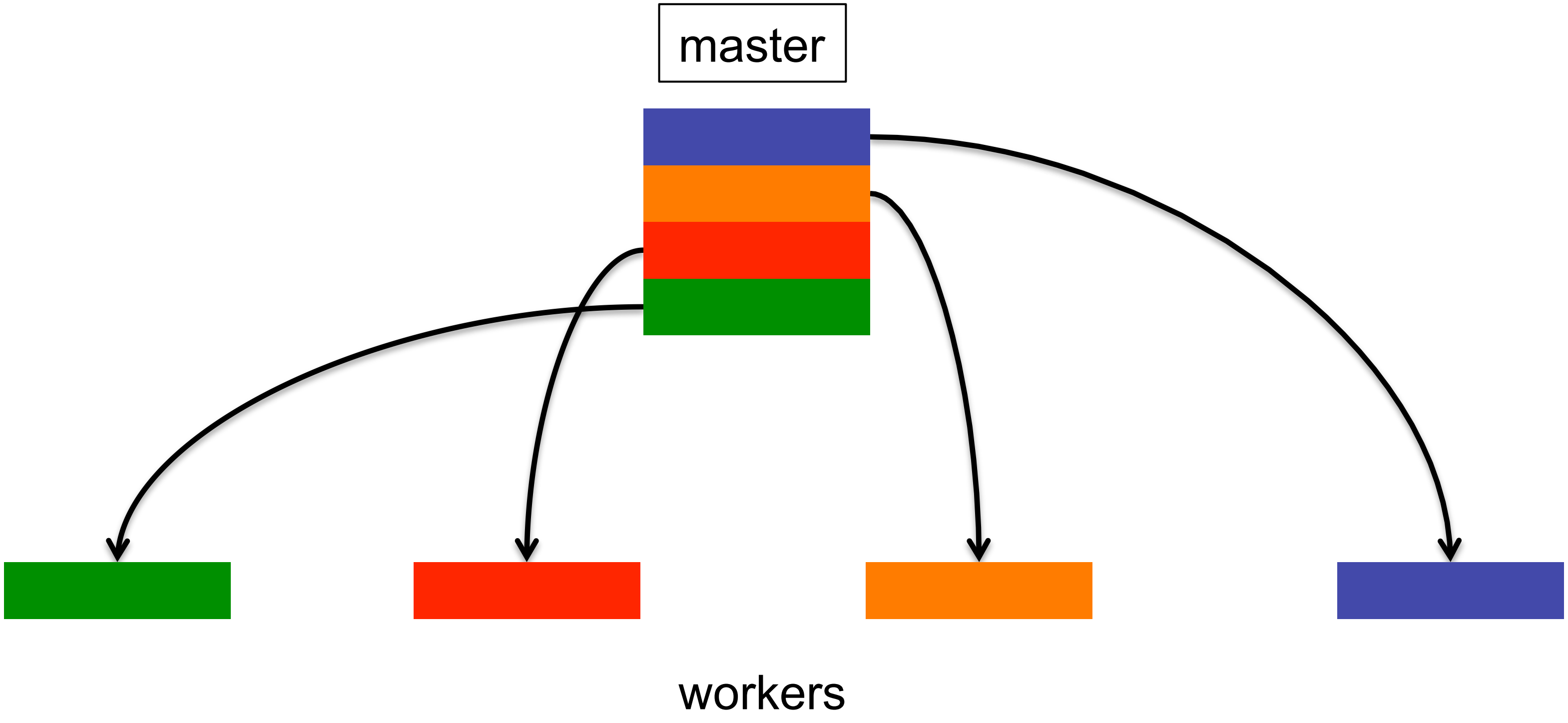
Task 3 – broadcast

- Broadcast of matrix dimensions by master
  - Send the same value to every worker



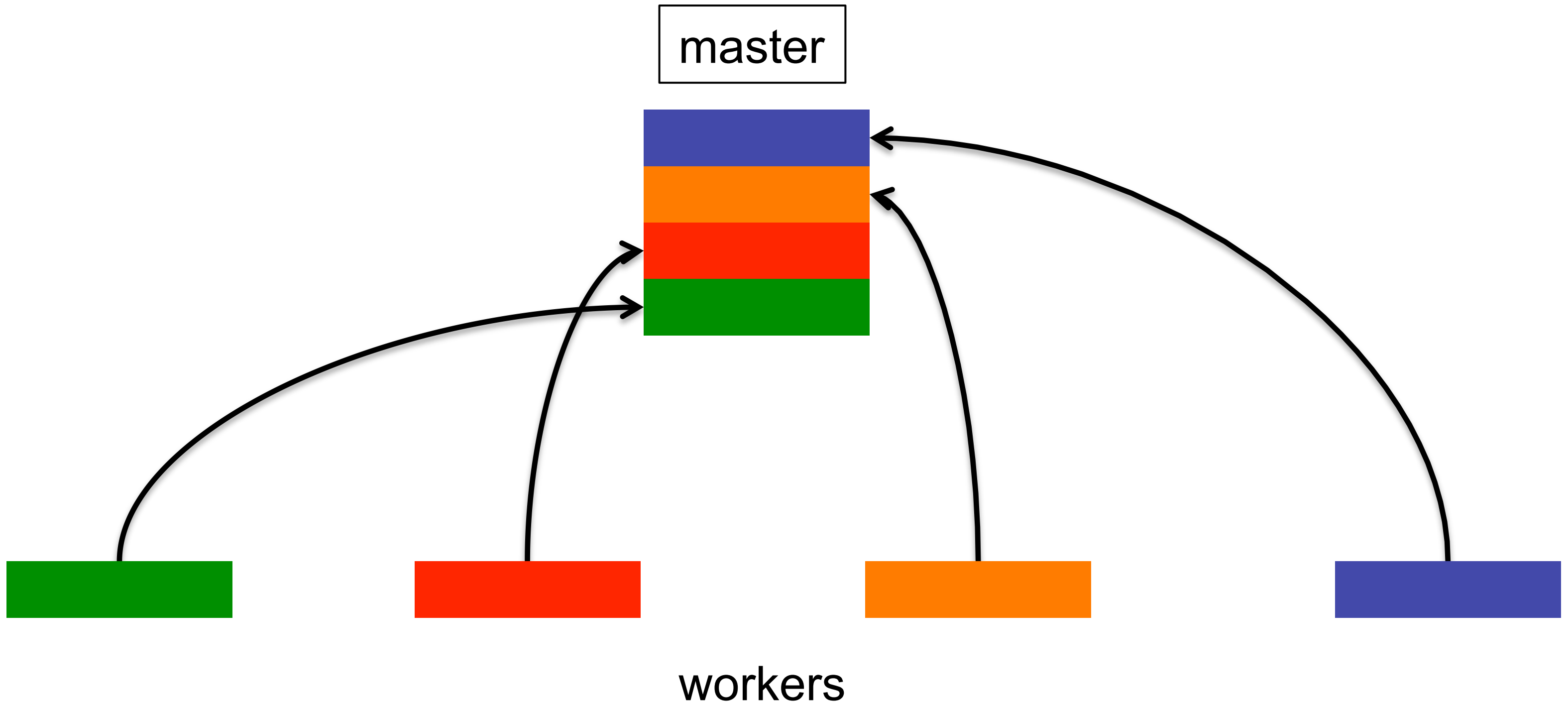
Task 3 – scatter operation

- Distribution of array by master
  - Still scatter operation



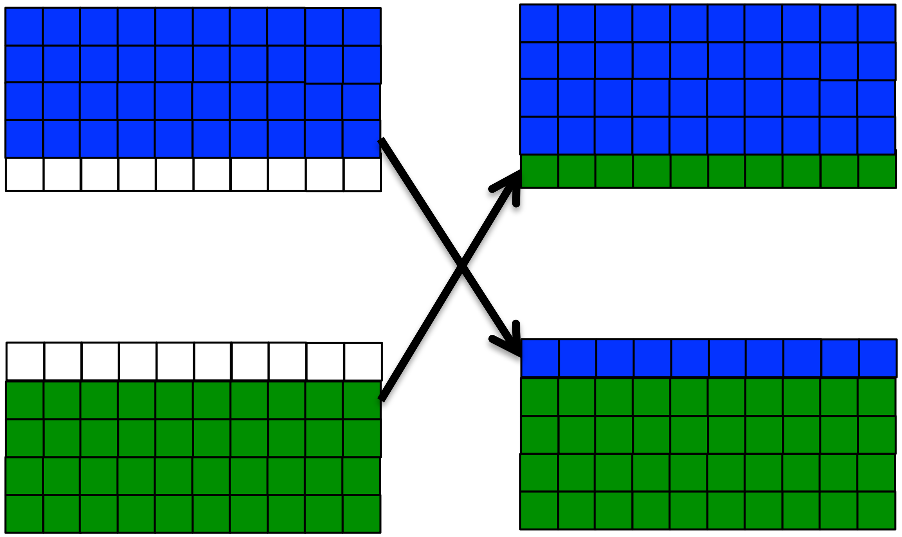
Task 3 – gather operation

- Gathering of sum array by master
  - Each worker sends data to master



Task 3 – communication between workers

- Median filter required exchange of data between workers
  - Simple point-to-point communication between two processes
    - One process sends
    - Other process receives



Task 3 - summary

- Basic operations
  - Broadcast
  - Scatter
  - Gather
  - Send/Recv (point-to-point)

- MPI provides these functions (and many more)