

# Computação Paralela

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## MPI program profile

These exercises aim to measure the profile of a MPI program, splitting the parallel execution time into computation, communication and free time.

Consider the program to compute primes numbers, using a pipeline of three processes:

```
if (myrank==0) {
    PrimeServer *ps1 = new PrimeServer();
    ps1->minitFilter(1,SMAXP/3,SMAXP);

    for(int i=0; i<10; i++) {
        generate(i*pack, (i+1)*pack, ar);
        ps1->mprocess(ar,pack/2);
        MPI_Send( ar, pack/2, MPI_INT, 1, i, MPI_COMM_WORLD);
    }
} else if(myrank==1) {
    PrimeServer *ps2 = new PrimeServer();
    ps2->minitFilter(SMAXP/3+1,2*SMAXP/3,SMAXP);

    for(int i=0; i<10; i++) {
        MPI_Recv( ar, pack/2, MPI_INT, 0, i, MPI_COMM_WORLD, &status );
        ps2->mprocess(ar,pack/2);
        MPI_Send( ar, pack/2, MPI_INT, 2, i, MPI_COMM_WORLD);
    }
} else if (myrank==2) {
    PrimeServer *ps3 = new PrimeServer();
    ps3->minitFilter(2*SMAXP/3+1,SMAXP,SMAXP);

    for(int i=0; i<10; i++) {
        MPI_Recv( ar, pack/2, MPI_INT, 1, i, MPI_COMM_WORLD, &status );
        ps3->mprocess(ar,pack/2);
    }
    ps3->end();
}
```

- 1) Change the program to measure the total computation time of each process (note: use `MPI_Wtime` to measure the time spent on all `mprocess` calls)
  - a) Is the computation time well distributed across all three processes? How does this load distribution impacts the program scalability?
  - b) Is it possible to improve the load distribution for a better scalability?
- 2) Change the (improved) program to also measure the communication time of each process by measuring the time spent on all MPI calls.
  - a) How does the communication time compare to the computation time? What is the impact of this ratio on the program scalability?
  - b) How it is possible to improve the communication to computation ratio? What is the trade-off on this case study?
- 3) Change the program to also measure the idle time of each process (clue: the time spent on (the first) `MPI_Recv` also includes idle time). A global barrier (`MPI_barrier`) can be used help to measure the idle time at the end of the processing.
  - a) How it is possible to reduce the idle time? What is the trade-off on this case study?