 Parallel and Distributed Computing

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Daniel Arrais, 69675 Miguel Nobre da Costa, 73359 Ricardo Amendoeira, 73373

Professor josé costa

Longest Common Subsequence

2nd part

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# Introduction

In the first part of this project we used OpenMP to parallelize our serial solution to the Longest Common Subsequence (LCS) problem on one machine with multiple cores. The aim of the second part is to use the Message Passing Interface, MPI, method of parallelization: use a cluster of multiple machines (although it can run on a single machine with multiple or even a single processor) running independent processes with no shared data on each of their processors and achieve parallelization by passing messages between them with the required data. OpenMP can be integrated with MPI to make use of the multiple cores of each processor and further improving the performance of the parallel implementation.

# Serial Implementation

The serial implementation used was the one delivered in the 1st part of the project, as the problem to be solved is the same (refer to that report for a detailed explanation of the implementation). As a summary, the complexity of the algorithm used is and uses a little over bytes of memory ( and are the lengths of the two provided strings).

# Parallel Implementation: MPI

One big problem arises when working with multiple machines: the lack of shared memory. Using the LCS problem as an example, if one process computes a part of the matrix, this change isn’t accessible to the other processes and there’s no trivial way to solve this complication without shared memory.

The Message Passing Interface (MPI) provides ways for processes to communicate and transfer data between them, allowing for one to one communication as well as some more complex forms like scatter, combine and others, as well as process synchronization. Using MPI we can solve the complication mentioned earlier and share the work done by one process with the others. It comes, however, with the downside of adding communication overhead that can be significant depending on implementation, so too much communication should be avoided.

Our MPI implementation to calculate the LCS of two strings divides the matrix in P blocks of horizontal lines, where is the number of lines of the matrix and the number of processes. Each process gets assigned its own block of lines, which it solves in squares of height and width. For some matrix sizes and/or number of machines isn’t an integer value and the remainder blocks are handled by the first/last process. This work division leads to more work imbalance overhead than MPI communication overhead, since each process can compute a fairly large amount of data before requiring access to data from another processor.

Because of the dependencies of the calculations (each anti-diagonal of the matrix depends on the values of the previous anti-diagonal) it’s not possible to start solving all line blocks at the same time (the first block of the last process depends on the last block of the first process, for example), causing the last process to wait for the first to solve its whole line before it can begin, slowing down the program. The solution found was to continuar.

Just like in out OpenMP implementation the vast majority of the execution time is on the function *computeMatrix*, so that’s the only part that we chose to parallelize.

# Results and Conclusions