Project 1 in TMA4280

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0.1 Introduction

The goal of this exercise was to sum

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{pi^2}{6}$$

in serial and paralell, using both **OpenMP** and **MPI**, and compare the results.

0.2 Serial code

A program designed to run only in serial was made. It generates a vector of elements $v(n) = 1/n^2$. It then computes the sum in double precision for some finite number of elements 2^k, and compares it to the limit of the sum. The program made to do this is called *single.c*, was compiled with a makefile and run with the following argument: `./single`.

0.3 Paralell code

When writing the program in paralell there are two choises, using **OpenMP**, or using **MPI**. We are going to explore both, working individually and together.

0.3.1 OpenMP

The program from 0.2 was rewritten to use **OpenMP** to be able to run in paralell. The resulting program is called *openmp.c*, it was compiled with a makefile, and run with the following argument `OMP_NUM_THREADS=P ./openmp k`, with $P = 2$ and $P = 4$ and $k \in \{3, \cdots, 14\}$.

0.3.2 MPI

The program *mpi.c* was written to use **MPI** to be able to run in paralell. Here processor 0 is respinsible for dividing the workload to all the other processors, and writing out the resulting difference between the limit and the sum.

It was neccesary to use **MPI_Send**, and **MPI_Recv** to tell the different processors which element they where responsible for making. Summing it all toghether was done conveinantly by the function **MPI_Sum**.

	Single	**OpenMP**, $P = 2$	**OpenMP**, $P = 8$	**MPI**, $P = 2$	**MPI**, $P = 8$
2^k	$1.175 \cdot 10^{-1}$	$1.175 \cdot 10^{-1}$			
2^3	$1.175 \cdot 10^{-1}$	$1.175 \cdot 10^{-1}$			
2^4	$6.059 \cdot 10^{-2}$	$6.059 \cdot 10^{-2}$			
2^5	$3.077 \cdot 10^{-2}$	$3.077 \cdot 10^{-2}$			
2^6	$1.550 \cdot 10^{-2}$	$1.550 \cdot 10^{-2}$			
2^7	$7,782 \cdot 10^{-3}$	$7,782 \cdot 10^{-3}$			
2^8	$3.899 \cdot 10^{-3}$	$3.899 \cdot 10^{-3}$			
2^9	$1.951 \cdot 10^{-3}$	$1.951 \cdot 10^{-3}$			
2^{10}	$9.761 \cdot 10^{-4}$	$9.761 \cdot 10^{-4}$			
2^{11}	$4.882 \cdot 10^{-4}$	$4.882 \cdot 10^{-4}$			
2^{12}	$2.441 \cdot 10^{-4}$	$2.441 \cdot 10^{-4}$			
2^{13}	$1.221 \cdot 10^{-4}$	$1.221 \cdot 10^{-4}$			
2^{14}	$6.013 \cdot 10^{-5}$	$6.013 \cdot 10^{-5}$			

Table 1: Data from solving the problem with different methods.

0.3.3 OpenMP and MPI

0.4 Results

The results from the different programs and setups are shown in table **??**.

0.5 Computational complexity

0.5.1 Memory usage

0.5.2 Floating point operations

0.5.3 Time consumption

0.6 Conclusion