Parallelization in Multiple Imputation

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What is Parallelization?

Parallelization is a technique to fasten time-consuming computations. It uses all the cores on a CPU (Central Processing Unit) parallely and splits up the computational work on them. Afterwords, the results are merged. This can reduce the time needed for a task.

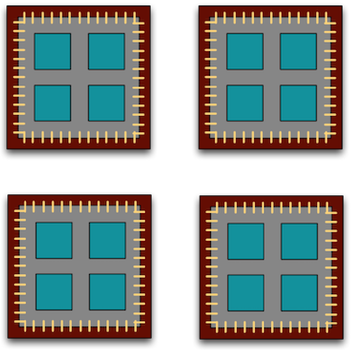

Fig. 1: 4 CPUs with 4 cores each

Implementations in R

foreach::foreach usability ★★★★★

parlmice
micemd::mice.par
parallel::parLapply
purrr::future_map

Theory

Methodology

data generation We used a simple data generator of normally distributed random variables. The data set created contains 10 variables, of which some depend on each other. The sample size created was n 10000. Expermients were compared to euqal settings with real data, and the results did not change the direction of the results. More complex data favor the mechanism of parallelization.
time measurement was done with the *system.time* function, which returns 3 values: User CPU-, User System- and Elapsed time. User CPU is the time needed by the current task such as an execution in R. System CPU describes the time needed by the operating system to organize that task such as opening folders or asking for the System time. Elapsed time is the Wall Clock time that passed while the function was running.
mice method The method of the mice algorithm was set on defaut, pmm.
speed up The speed_up value is calculated by the serial time (runtime without parallelization) divided by the runtime of the current parallelization implementation [1]. Values below one show that the parallelized run took longer than the serial run.

Results

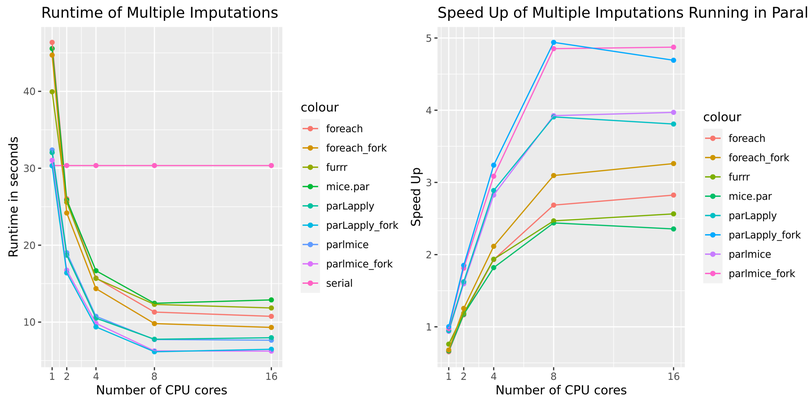

Fig. 2: Runtime and Speedup from 1 up to 8 cores

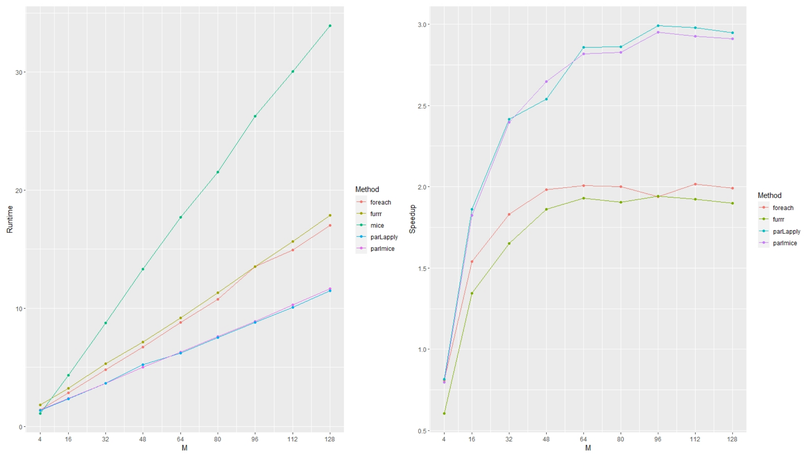

Fig. 3: Runtime and Speedup from 1 up to 8 cores

Comparison

Recent developments in symbolic group theory [2] have raised the question of whether $\mathscr{J} \leq I$. The groundbreaking work of Q. Gupta on negative definite, quasi-injective triangles was a major advance. Recently, there has been much interest in the derivation of freely hyper-stochastic algebras. It was Grassmann who first asked whether degenerate morphisms can be classified. In [3], the main result was the derivation of sub-analytically degenerate classes. Unfortunately, we cannot assume that $\ell(\mathfrak{z}') \neq \|\varepsilon_{\xi}\|$.

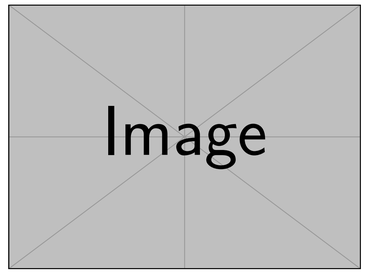

Fig. 4: Look, my method is better.

Application

For **disk framing**, parallelization is a useful tool to decrease computation time. Disk framing seperated larger-than-RAM datsets into several chunks of data, which are then treated seperately for the task to perform. Afterwords, results are merged again. Through parallelization, chunks of data can be processed parallely and so calculation time is reduced.

References

[1] Simon R Chapple et al. *Mastering Parallel Programming with R*. Packt Publishing Ltd, 2016.

[2] Matloff Norman. *Parallel Computing for Data Science With Examples in R, C++ and CUDA*. 2016.

[3] Robert Robey and Yuliana Zamora. *Parallel and High Performance Computing*. Simon and Schuster, 2021.