Efficient computation of the classical bound of Bell correlation and prepare-and-measure witnesses in parallel environments

István Márton[1]
Erika Bene[1], Péter Diviánszky[2], Gábor Drótos[1]

HUN-REN Institute for Nuclear Research P.O. Box 51, Debrecen, H-4001, Hungary
Faulhorn Labs, Budafoki 91-93, Budapest, H-4117, Hungary

marton.istvan@atomki.hu

Abstract

We present a program speeding up the brute force calculation of the L_d norms of an n×m matrix M. The L_1 norm stands for the local bound of the Bell expression [1], meanwhile L_d norms where $d \geq 2$ are the classical d-dimensional bounds of the prepare-and-measure (PM) witness [2]. In both cases we assume binary outputs. These norms are of interest in the field of communication complexity, the Grothendieck constant, or in graph theory. The effectiveness of our implementation is based on two factors. On one hand, our code capitalizes on efficient implementation of the algorithm calculating the L_d norms with the use of special mathematical and programming techniques. On the other hand, our code is implemented in the C programming language with OpenMP, MPI or CUDA exploiting the advantages of the shared or distributed parallelism, or capable utilizing massively parallel platforms, namely Graphics Processing Units (GPUs).

References

[1] P. Diviánszky, E. Bene and T. Vértesi, Phys. Rev. A, **96** (2017) 012113
[2] P. Diviánszky, I. Márton, E. Bene and T. Vértesi, Scientific Reports, **13** (2023) 13200

Figures

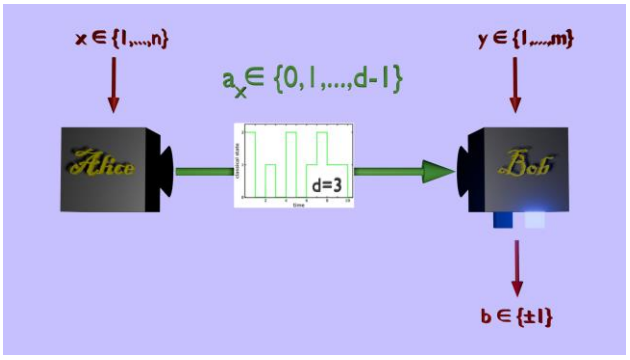

Figure 1: The prepare-and-measure setup using a classical dit of communication. The inset illustrates an implementation of the d=3 case.

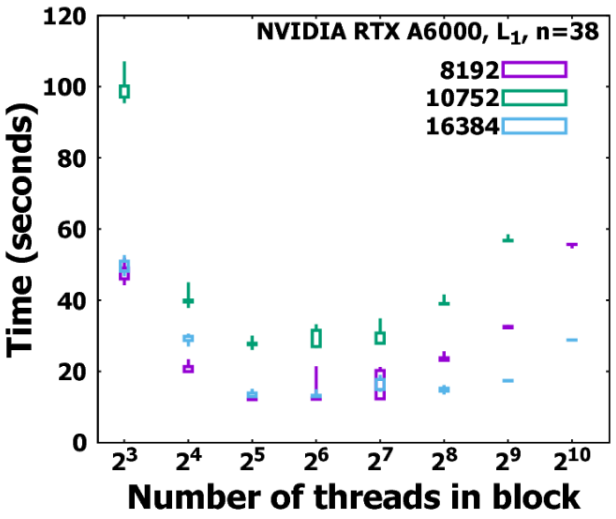

Figure 2: Execution times for computing the L_1 norm of a 38 × 38 matrix with an NVIDIA RTX A6000 graphics processing Unit, as a function of the number of threads in a block. The total number of threads are constant depicted with markers plotted with the same color and as indicated in the legend.