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Towards an efficient many-core implementation of the IRKA

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The modeling of physical phenomena as Linear Time Invariant systems is a common practise across science and industry. It is often the case that the order of these models is so large that it renders them unuseful at the time of simulating the studied system. In these cases, practitioners can appeal to Model Order Reduction (MOR) techniques, which departing from the original model produce a reduced one with much lower order and similar behaviour.

One of the most well known techniques is the Iterative Rational Krylov Algorithm (IRKA). The method departs from an initial Reduced Order Model, represented by a set of shifts, and iteratively refines this set until the shifts converge to an optimal ROM. This refinement involves, in each step, the solution of two shifted linear systems $(\sigma_i E - A)x = b$ and $(\sigma_i E - A)^T y = c$.

In this work we study the use of the BiCG algorithm to solve those sequences of dual pairs on heterogeneous CPU-GPU platforms. With this purpose, we compare the use of a direct solver, a CPU and a GPU implementation of the BiCG, from the runtime and energy consumption points of view.

Our initial results using the Rail test case, and fixing the amount of work for the BiCG solvers per IRKA iteration, seem to indicate that, for large test cases, using the accelerator can effectively reduce the runtime of the BiCG, increasing the energy consumtption only slightly. This result is promising, and motivates the work on the series of BiCG applications to improve their convergence. For example, the use of preconditioners and recycled Krylov spaces should be explored in the future.

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