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Abstract: Matrix multiplication is a major cornerstone in exact linear algebra: its study can concern algorithmic, complexity, design, reduction, *etc.* problems. We are interested in the few following aspects.
We first expose, in this thesis, efficient exact matrix multiplication techniques, developed for both multiplication ($A = B \times C$) and product with accumulation ($A = A + B \times C$). We set up new schedules that allow us to minimize the extra memory requirements during a Strassen–style matrix multiplication, while keeping the complexity competitive with Winograd's multiplication algorithm. In order to obtain them, we develop external tools (pebble games), tight complexity computations and new hybrid algorithms.
We then use parallel technologies (multicore CPU and GPU) in order to efficiently accelerate the sparse matrix–dense vector multiplication (SpMV) or sparse–matrix dense matrix multiplication (SpMM), crucial to *blackbox* (block) algorithms. We also set up new hybrid, environment dependant, sparse matrix formats that help yield large speed-ups. We exemplify these results by speeding up the block Winograd rank algorithm in the LinBox library.
Finally, we establish generic design methods focusing on efficiency, especially via *building block* conceptions or self-optimization. We also propose tools for improving and standardizing code quality in order to make it more sustainable and more robust. This is applied in particular to the LinBox computer algebra library.