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Computational Complexity of Addition with Multidimensional Digit Representations

Vectors with integer entries, like integers, can be represented with a digit representation with a base (radix) matrix and a finite set of digit vectors. Standard algorithms for multi-digit addition can then be extended to new addition algorithms for vectors, beyond the standard component-wise addition. Digit representations for integers, including the base-10 Hindu-Arabic numeration system and binary representations, were major advances in mathematics, enabling efficient computations, with numerous important consequences. We ask whether digit representations for vectors can yield further advances in computational efficiency.

Some surprising results occur in the multidimensional setting: addition may be of quadratic rather than linear complexity ($O(n^2)$ instead of $O(n)$, where n is the length of input), and for some addition tables, the standard multidigit addition algorithm may not terminate. Workarounds exist in some cases, making use of an idea similar to the two's complement algorithm for subtraction in one dimension. This talk will briefly review the construction of multidimensional radix representations, will summarize the work recently completed in the Master's thesis of M. ALmutairi, and will present some variations of the addition algorithm that may simplify multidigit addition in the multidimensional setting.