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Tensors: From Entanglement to Computational Complexity

The quantum state of a system of k particles can be viewed as a tensor of order k. Local stochastic operations on a quantum state correspond to the application of linear maps to the indices of the corresponding tensor and are studied in entanglement theory and implemented in current quantum information science experiments.

Interestingly, the notion of tensor transformation is at the heart of the study of the computational complexity of algebraic problems such as the multiplication of matrices. Strassen's breakthrough algorithm for the multiplication of d-by-d matrices that runs faster than your standard d^3 high-school algorithm, spurred a whole development of tensor theory.

I will review these connections and present a new family of quantum information-inspired functionals that can serve as obstructions for asymptotic tensor transformations. The functionals are the first of their kind, thereby solving a problem of Strassen from 1986.