Memcomputing: Leveraging Memory and Physics to Compute Efficiently

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It is well known that physical phenomena may be of great help in computing some difficult problems efficiently. A typical example is prime factorization that may be solved in polynomial time by exploiting quantum entanglement on a quantum computer. There are, however, other types of (non-quantum) physical properties that one may leverage to compute efficiently a wide range of hard problems. In this talk, I will discuss how to employ one such property, memory (time non-locality), in a novel physics-based approach to computation: *Memcomputing* [1, 2, 3, 4]. As examples, I will show the polynomial-time solution of prime factorization, the search version of the subset-sum problem [5], and approximations to the Max-SAT beyond the inapproximability gap [6] using polynomial resources and self-organizing logic gates, namely gates that self-organize to satisfy their logical proposition [5]. I will also show that these machines are described by a topological field theory, and compute via an instantonic phase, implying that they are robust against noise and disorder [7]. The digital memcomputing machines we propose can be efficiently simulated, are scalable and can be easily realized with available nanotechnology components. Work supported in part by MemComputing, Inc. (http://memcpu.com/) and CMRR.

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