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Theoretical and Computational Ising Model Studies: Work and Time Costs of Information Erasure FRANCIS CAVANNA, University of Dallas, ARTEMY KOLCHINSKY, Santa Fe Institute — An Ising model is used to test whether computational operations optimize at critical points, which are specific values dividing two distinct phases of a statistical system. The Ising lattice takes a bit value of 1 for an average magnetization (or net magnetization) greater than 0 ($M > 0$), and a bit value of 0 if ($M < 0$). The simulation is varied through multiple values of k_BT to replicate the phase transition at the critical point $k_BT = 2.269$. Next, the minimum values of the required external magnetic field h and the associated work consumption are found for performing the boolean computational operation RESET TO ZERO on a 4x4 Ising lattice with the following erasure success rates: 0.75, 0.80, 0.85, 0.90, and 0.95. Finally, a time-evolving Ising lattice simulation is performed for the 4x4 lattice to measure the time required to drive the net magnetization to 0 from an initial value of 1 with and without negative external magnetic fields. All programs use Jupyter Notebooks and Python 3.6.1. The work required for a RESET TO ZERO operation for any arbitrary tolerance is found to approach 0 as k_BT approaches 0, but the time for the operation with the minimum required external magnetic field appears to go to infinity.

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