

Ising Model Solver for Combinatorial Optimization Problem

Levy Lin

*Department of Computer Science
Department of Economics
Rensselaer Polytechnic Institute
Troy, United States
linl9@rpi.edu*

Holden Mac Entee

*Department of Computer Science
Department of Electrical, Computer & Systems Engineering
Rensselaer Polytechnic Institute
Troy, United States
macenh@rpi.edu*

The Ising model, a mathematical model of a magnetic material, provides a description of the energy of a system of atoms [1]. It is modeled by random spin-interactions depicted as: $\sigma \in \{-1, +1\}$. For the purpose of this document, we will consider the spin-glass Ising model. That is, the spins are randomly distributed between ± 1 . Ising spin glass models are NP-Hard problems for classical computers. Naturally, we are able to correlate this property to all NP-Hard problems, and can be justifiably stated that Ising spin glasses are able to be polynomially mapped to all other NP-Hard problems [2].

REFERENCES

- [1] Carlson, C., Davies, E., Kolla, A., & Perkins, W. (2022). Computational thresholds for the fixed-magnetization Ising model. *Proceedings of the 54th Annual ACM SIGACT Symposium on Theory of Computing (STOC 2022)*, 1459–1472. <https://doi.org/10.1145/3519935.3520003>
- [2] Lucas, A. (2014). Ising formulations of many NP problems. *Frontiers in Physics*, 2(5). <https://doi.org/10.3389/fphy.2014.00005>
- [3] King, A. D., Bernoudy, W., King, J., Berkley, A. J., & Lanting, T. (2018). Emulating the coherent Ising machine with a mean-field algorithm. *arXiv*. <https://doi.org/10.48550/arXiv.1806.08422>