Usage Report for Fiscal Year 2022

Project Title:

Benchmarking CIM algorithms for solving combinatorial optimization problems

Name:

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1. Background and purpose of the project, relationship of the project with other projects

We are developing machines called Ising machines that can solve combinatorial optimization problems. In principle, such machines can solve NP-hard problems faster than the current state of the art. Thus, the goal of this project is to use Hokusai for: 1) Tuning the parameters to optimize the solver capability; 2) Evaluate the solver using different problems; 3) Compare the FPGA results with the CPU results and the state-of-the-art.

2. Specific usage status of the system and calculation method

Two algorithms based on the Ising model are being evaluated: spiking Chaotic Amplitude Control (sCAC) developed with our collaborators, and discrete Simulation Bifurcation Machine (dSBM) developed by Toshiba. Both algorithms are using the same types of problem, ranging from problem size N=100 to N=16000, and generate an optimal solution, a success probability, and a time-to-solution.

3. Result

We previously showed that our algorithm and the hardware we developed is faster than the state-of-the-art when comparing for fully connected graphs. Other types of graphs have also been generated for benchmarking. However, it seems that the algorithm fails to solve problem size higher than N=8000. Moreover, energies higher than the theoretical prediction are found.

4. Conclusion

We can show that our physical FPGA hardware reproduces similar behavior as Hokusai. These results are as of today better than the state-of-the-art in terms of computation speed. We generated and benchmarked other types of graphs and performed parameter tuning. However, the algorithms fail to compute fully connected problems beyond N=8000.

5. Schedule and prospect for the future

We were able to gather results showing the capability of our algorithm and hardware to solve combinatorial optimization problems. We would like to investigate why the algorithm fails to solve problems beyond N=8000. We might also need to modify the algorithm itself and reiterate the parameter tuning and the benchmark.

6. If no job was executed, specify the reason.

Fiscal Year 2022 List of Publications Resulting from the Use of the supercomputer

[Poster presentation]

F. Khoyratee, T. Leleu, S. Reifenstein, S. Kako, F. Nori and Y. Yamamoto, Neuro-inspired cyber-CIM on FPGA for combinatorial optimization, 2022, Coherent Network Computing 2022