Performance Evaluation of Support Vector Machine with Quantum-inspired Annealers

Ryoga Fukuhara†, Makoto Morishita† Takahiro Katagiri‡ Masatoshi Kawai‡ Tetsuya Hoshino‡ Toru Nagai‡

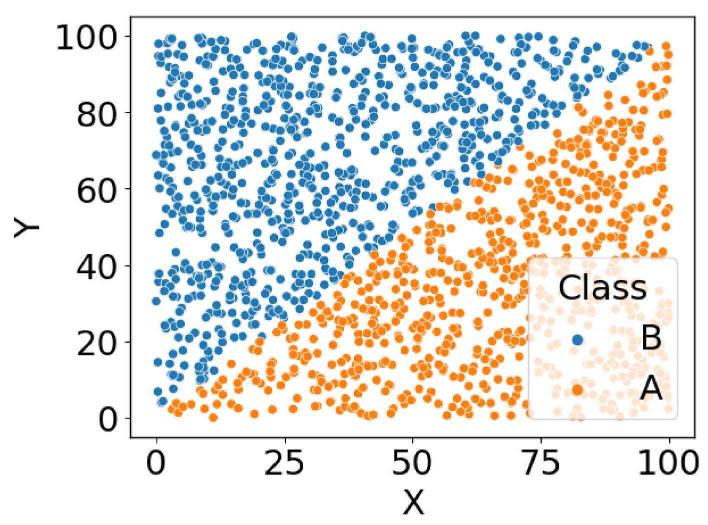
Graduate School of Informatics, Nagoya University† Information Technology Center, Nagoya University‡

Introduction

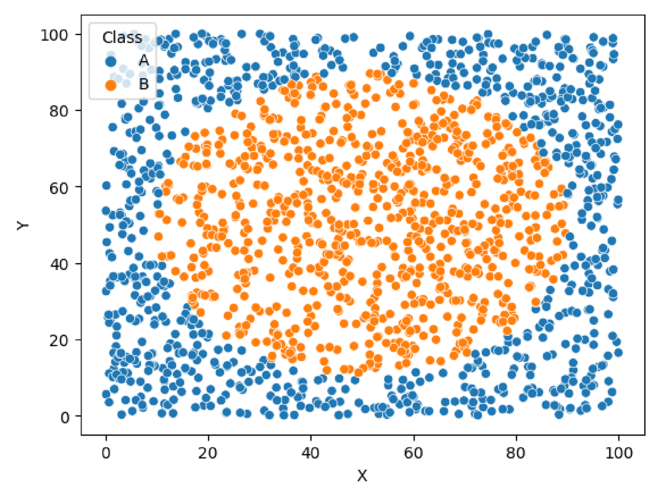
Quantum computers, drawing considerable attention due to their capacity for simultaneous parallel computations stemming from their quantum nature, are poised to emerge as the next-generation high-speed computing systems, boasting vastly superior computational capabilities compared to conventional, or classical, computers. Among them, when it comes to addressing combinatorial optimization problems , there is a diversification of quantum annealing methods, semiconductor annealing machines, and other quantum-related hardware. Notably, semiconductor annealing machines have garnered attention as non-von Neumann computers capable of performing annealing processes to rapidly derive optimal solutions for combinatorial optimization problems at room temperature. Nevertheless, the range of practical applications for these machines is not yet extensive. As a result, in this study, we undertook the implementation of SVM (Support Vector Machine) [1], a well-established machine learning algorithm on quantum-inspired annealers.

Experimental Settings

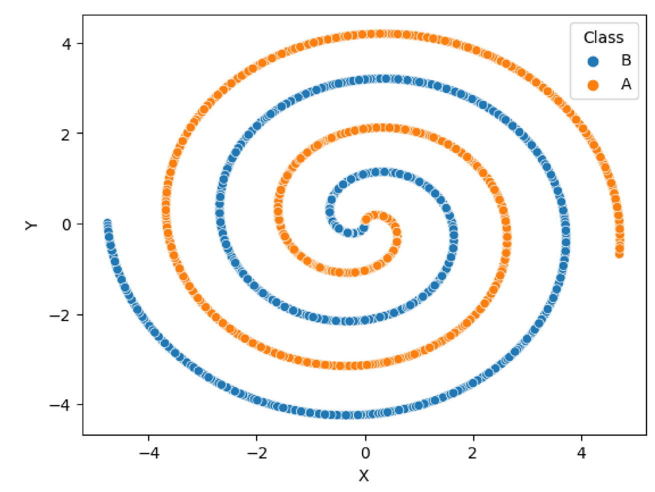
- Three types of problems: one linearly separable and two non linearly separable
- Generate data using random numbers and label A and B according to their decision



Linearly Separable



Non Linearly Separable(1)



Non Linearly Separable(2)

Experimental Procedures

1. Split 1600 sample data into 100 training data, 1000 validation data, and 500 test data
2. Create a classifier from training and validation data to determine best parameters
3. Apply the classifier and parameters obtained in 2 to the test data and calculate the percentage of correct answers

Result

	Linearly Separable	Non Linearly Separabl(1)	Non Linearly Separable(2)
Classical	96.4%	98.8%	90.6%
CMOS	98.4%	89.8%	71.2%
Amplify AE	98.0%	94.3%	74.8%
Classical(5% Error)	92.4%	93.6%	83.4%
CMOS(5% Error)	89.0%	84.6%	69.6%
Amplify AE(5%error)	90.2%	87.4%	68.2%

- Compared to the classical computation environment, the quantum-inspired annealer environment produced comparable or inferior results.
- However, our evaluation also highlighted the important role of tuning the SVM-specific hyperparameters during execution on the quantum inspired annealer, which has a significant impact on solution accuracy.

References:

[1] V. N. Vapnik, “The Nature of Statistical Learning Theory. Springer”, New York, 1995.

Acknowledgments

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