

A close-up photograph of a human hand holding a black-gloved hand. The human hand is positioned at the top, with fingers wrapped around the wrist and back of the gloved hand. The gloved hand is held in a way that suggests it is being supported or examined. The background is a plain, light gray color.

**Solve problems human
beings cannot solve.**

Introduction

Yuichiro Minato
CEO of MDR Inc.



Univ. of Tokyo (Architecture)
Kengo Kuma & associates (Architecture)

2008- MDR Inc.

2015- QC project adopted by ministry of internal affair and communications.

2017- Associate program manager on ImPACT project

2019- Advisor on Presto / Sakigake



MDR Overview

Company Name	MDR Inc. (Machine learning & Dynamics Research)
Location	ABC Ground 3-1-1-B2F, Marunouchi, Chiyoda, Tokyo, Japan
Established	2008
Capital	\$2,300,000
Business	Quantum Computer Fullstack, Software, Middleware, Hardware
Employee	19 (including advisor, parttime job)
Applications	Machine Learning, Optimization, Quantum Simulation, Cryptography
Business Area	Security, Self-driving car, Quantum Chemistry, Digital Marketing



Our Team

Yuichiro Minato

CEO

Quantum Application
& Library

Project manager at
Japanese cabinet office
quantum computing project
Tokyo Univ.



Yoichi Takebayashi

CFO

Goldman Sachs
Morgan Stanley
Columbia Univ.
Tokyo Univ.



Asa Eagle

Quantum Application &
Solution

NEC

Avelio Systems (Founder)
Tokyo Institute of Technology



Takumi Kato

Quantum Application
& Library

Tohoku Univ.



東北大学

TOHOKU UNIVERSITY

Daisuke Saida

Quantum Hardware

Toshiba

Tokyo Univ. (Ph.D)



Narii Watase

Quantum Hardware

Microsoft

Tokyo Institute of Technology



Hitoya Nakamura

Solution

Toshiba

PwCC/IBM

Sony Global Solutions

Tokyo Institute of Technology



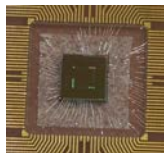
Shinji Ishihara

Finance

ABC Finance (Director)

Mitsubishi UFJ Bank

Chuo Univ.



Over 2300 Quantum Computing Application Community.



around 400 people at once event

“FUGAKU” the next gen 400 Peta flops flagship HPC

会員限定有料記事 毎日新聞 2019年9月2日 19時46分 (最終更新 9月2日 21時42分)

社会一般 > 速報 > 社会 > 科学・技術 > サイエンス >



次世代スパコン「富岳」のロゴマーク＝理化学研究所提供

理化学研究所のスーパーコンピューター「京（けい）」（神戸市）が8月で運用を終えた。2012年9月に本格運用を開始して以来、世界トップクラスの性能を誇り、従来は時間がかかりすぎて不可能だったシミュレーションを実現するなど研究の進展に貢献した。21

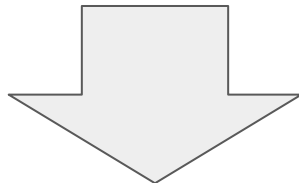
<https://mainichi.jp/articles/20190902/k00/00m/040/211000c>

Dynamic Optimization



Background

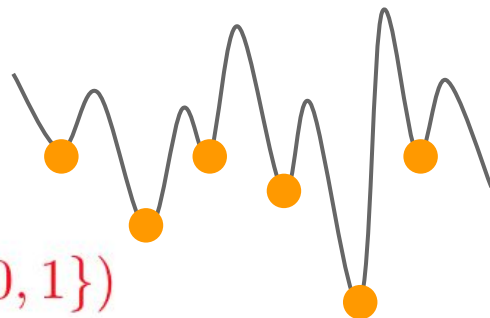
- **Formulation of ising model** is complicated for customers
- We **don't have enough number of engineers** on quantum computer
- We need perspective on quantum computer to do **scalable business (not PoC)**



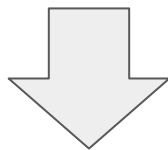
We just need easy to use business framework for ising model
(We now have too much clients for small number of engineer)

Sampling from the ising QUBO

get array of qubits from the generative model of ising model



$$H = \sum_i h_i \sigma_i + \sum_{i,j} J_{ij} \sigma_i \sigma_j \quad (\sigma_i, \sigma_j \in \{0, 1\})$$



get samples

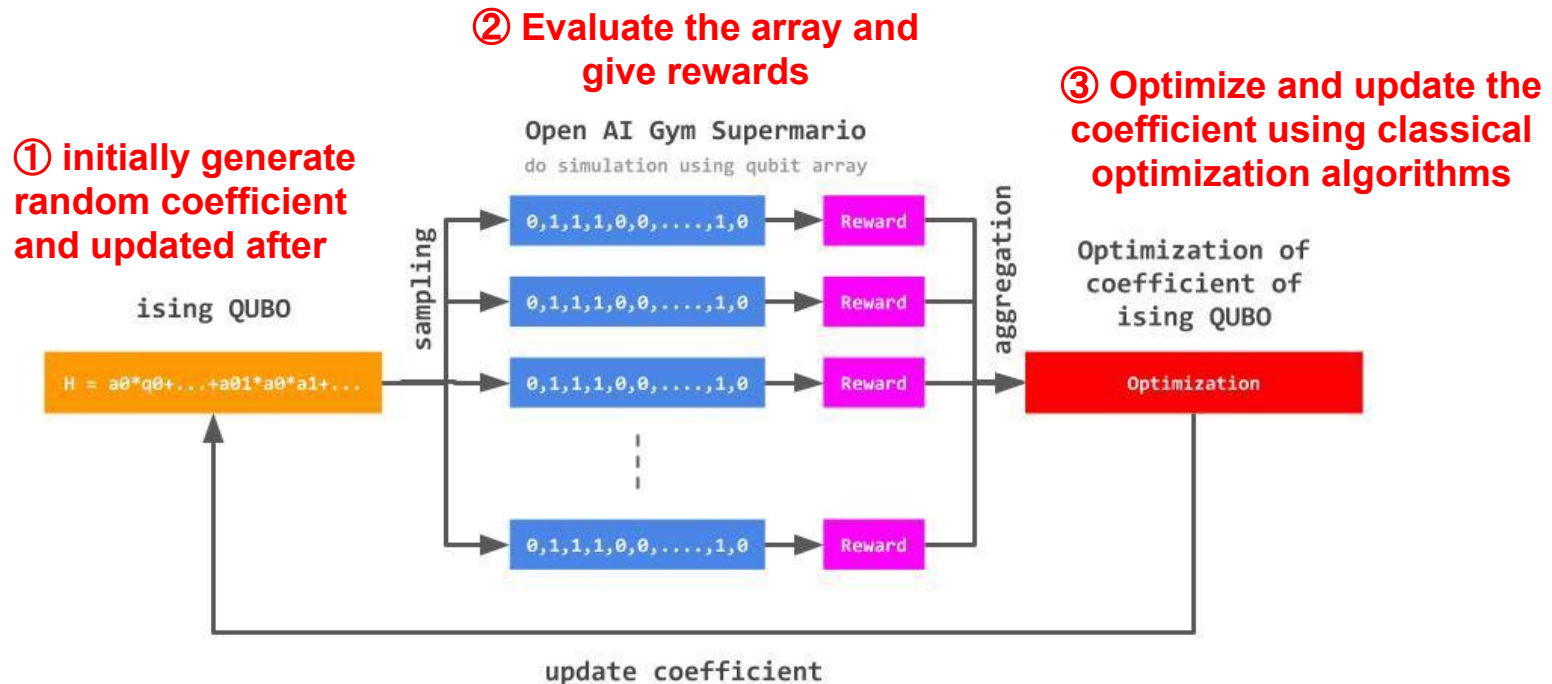
[0,1,1,1,1,0,1,1,1,1,1,0,0,0,0,0,0, ... ,1,1,1,1]

⋮

[1,1,0,1,0,1,1,0,0,1,1,0,1,1,1,0,0, ... ,1,1,0,1]

Overview of Machine Learning Frameworks for QUBO

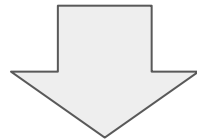
Practical business scheme based on reinforcement like optimization process



Step1 : initial generation of samples

Estimate the number of qubits to use and prepare QUBO coefficients as random number

$$H = \text{beta} * (0.32*q_0 + 0.23*q_1 + 0.41*q_2 + \dots + 0.52*q_0*q_1 + 0.6*q_0*q_2 + \dots)$$

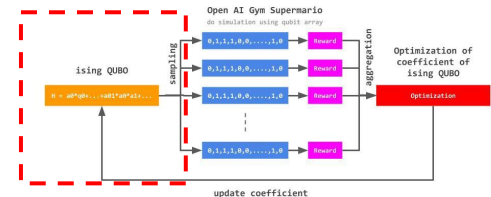


generate qubits samples

[0,1,1,1,1,0,1,1,1,1,1,0,0,0,0,0,0, ... ,1,1,1,1]

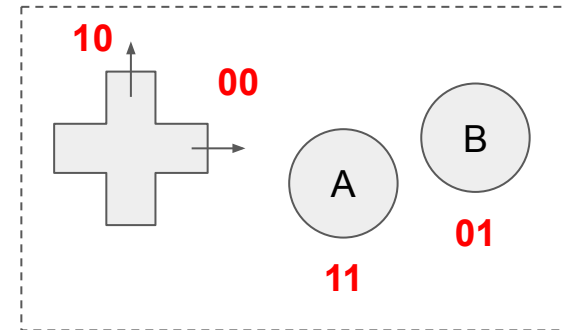
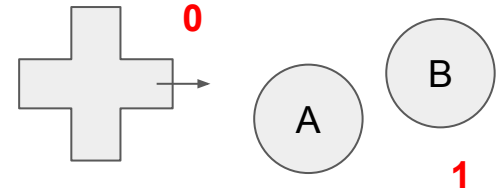
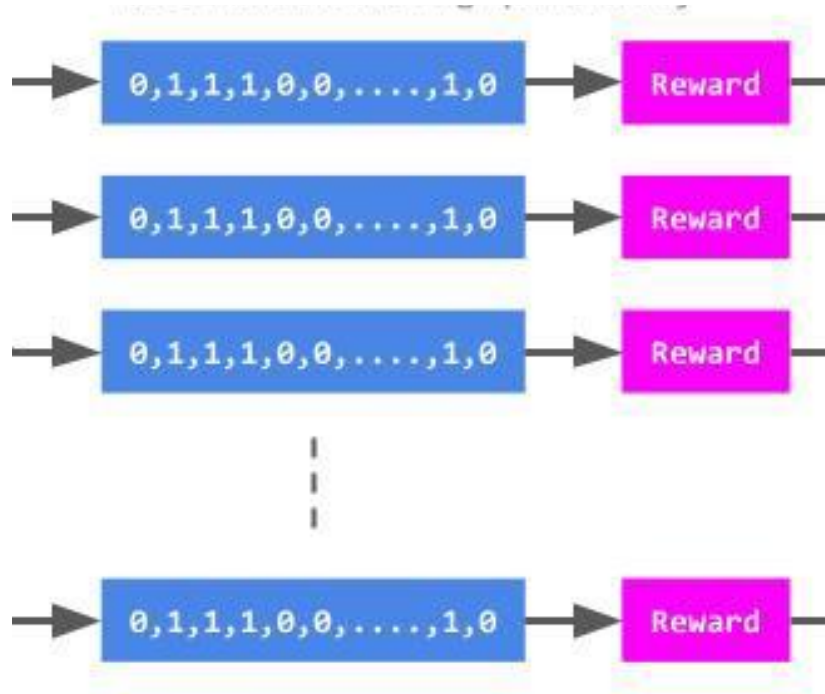
⋮

[1,1,0,1,0,1,1,0,0,1,1,0,1,1,1,0,0, ... ,1,1,0,1]

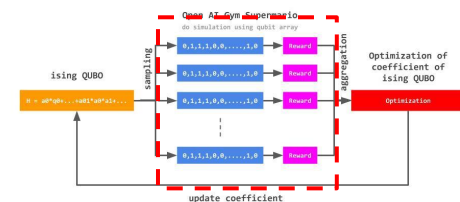


Step2 : Evaluate Samples through trials

Try and get rewards corresponding to the action of qubits array



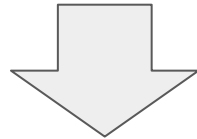
if needs much more complicated action, use the combination of binary array.



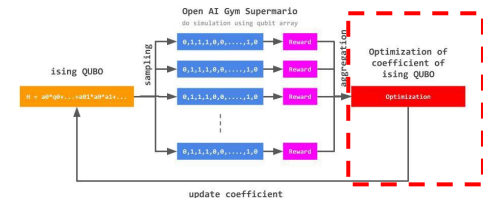
Step3 : Optimize initial QUBO coefficient

Here one example we are using classical optimization algorithm to update coefficient

$$H = \text{beta} * (0.5*q_0 + 0.5*q_1 - 0.62*q_2 + \dots + 0.48*q_0*q_1 + 1*q_0*q_2 + \dots)$$

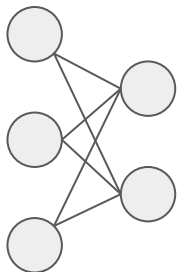


Continuously doing this process, **we can get much better sampling result** from QUBO formulations.

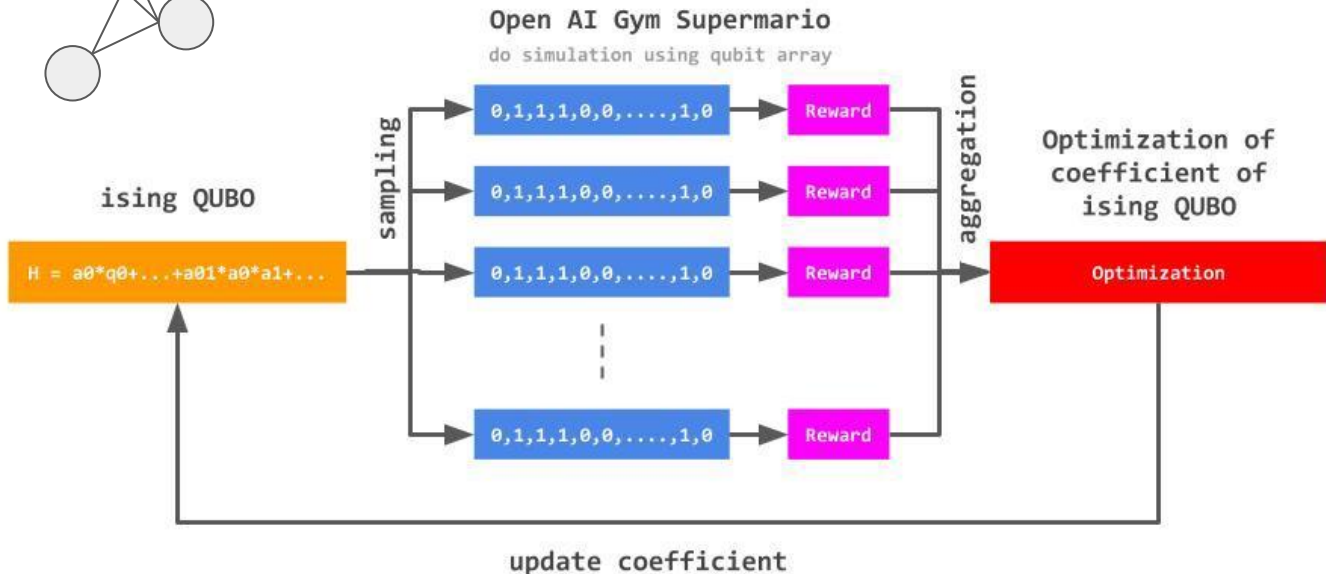


Overview Again

Generated randomly and through optimization we can get better ising QUBO

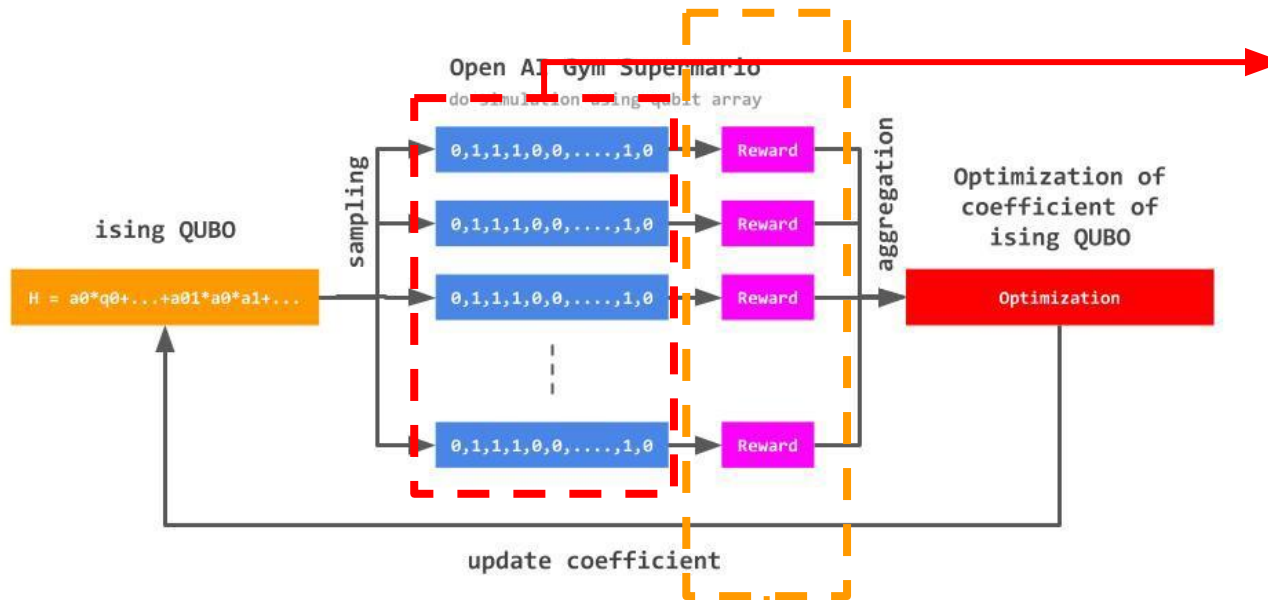


We want to adopt much more efficient models for initial ising QUBO like RBM or other generative models, but at the moment we are using very simple model



Dynamic Creative : another development

Using this scheme we can evaluate human qualitative as a coefficient of ising model

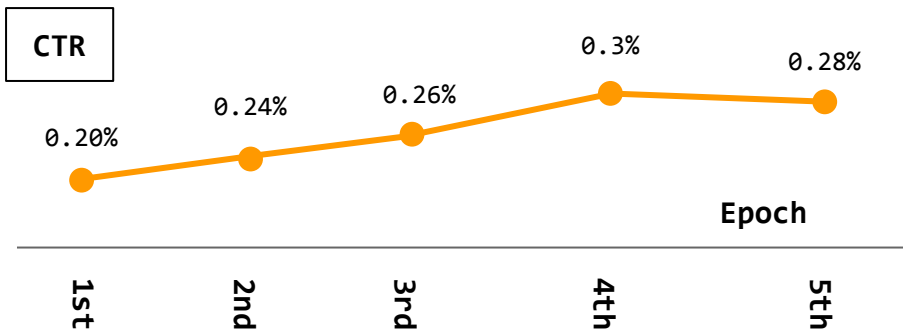
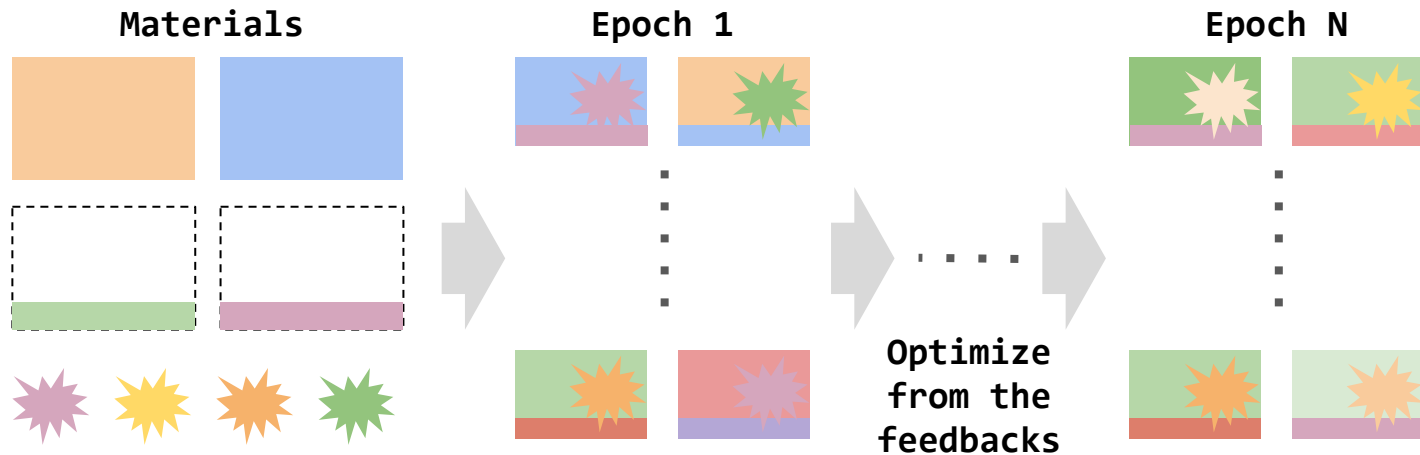


List these samples by evaluating relatively, and give score according to the order.

Converting a relative evaluation into the absolute evaluation, we can score the human qualitative

Example of improvement of Click Through Rates of Ads

Prepare the materials and do many trials to update using QUBO from feedbacks

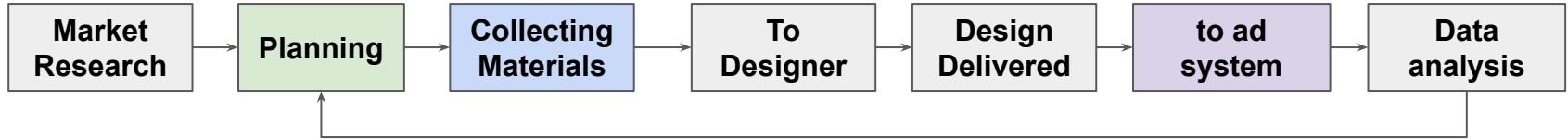


*not guarantee to go to the global minimum.

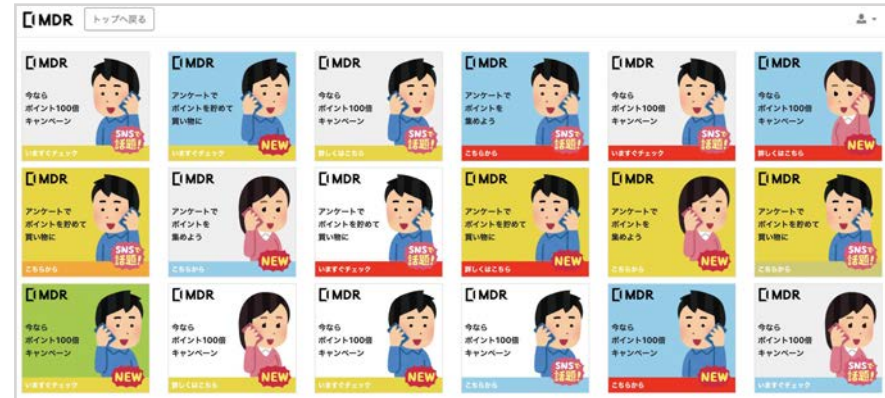
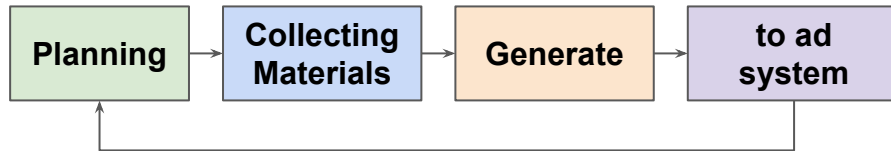
Advertisement optimization.

Improve advertising effectiveness and reduce human-labor

Before



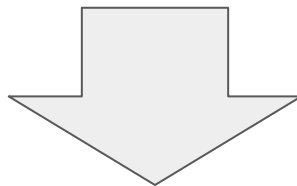
After



Summary

Business scheme using machine learning

- **Formulation of using model** is complicated for customers
- We **don't have enough number of engineers** on quantum computer
- We need perspective on quantum computer to do **scalable business (not PoC)**



- **Do formulation automatically** learning from the result of qubits array as actions.
- Converting relative evaluation to absolute, we can **evaluate qualitative values**.
- **Business scales** and people use a lot of machine time on **D-Wave continuously!**



Name : MDR Inc.

Location : ABC Ground 3-1-1-B2F, Marunouchi, Chiyoda, Tokyo, Japan

Contact : info@mdrft.com

Website : <https://mdrft.com/>