

Quantum Computers for Nuclear/Particle Physicists

Day 2.

Questions about Yesterday's talk

[Atsushi Nakamura](#) and [Taizo Sasaki](#)

May, 2023

You can download Yesterday's file at

<https://eikai.co.jp/2023/05/2691/>

Still unclear why Quantum Computers
calculate with high speed

- 🔍 Quantum computers use qubits as their unit of data. Qubits, unlike bits (which take a value of 1 or 0), can also be between 1 and 0 at the same time, existing in multiple states at once. This is known as superposition.

You said NTT's documents are useful.
But NTT is a telephone company

📍 Yes, NTT (NIPPON TELEGRAPH AND TELEPHONE CORPORATION) is a giant telephone company. But they have been serious for future technology. See their page <https://www.nttdata.com/jp/ja/services/quantum/>

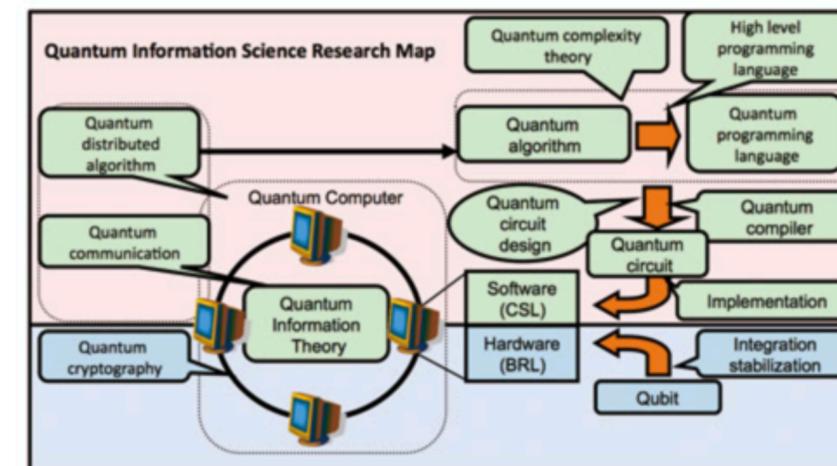
NTT R&D Japanese

NTT R&D Website > NTT Communication Science Laboratories > Organization Information Science

Quantum Information Science

Theoretical Research on Information Processing Based on Principles of Quantum Mechanics

Quantum information science is an interdisciplinary field that combines information science and quantum physics. Cooperation between software and hardware researchers is critical. NTT undertakes strategic research on quantum information science at the NTT Communication Science Labs. (CSL) and NTT Basic Research Labs. (BRL), which promote software and hardware research, respectively.



Our research has three phases: Elucidation of the Nature of Quantum bits, Development of Quantum Algor and Implementation of Quantum Operations. The results of this research are fed back to the hardware research at the NTT

More News after “Where are Quantum Computers in Japan(2)”



IBM Quantum System One with **Eagle**
127 Qbits (**Tangle Lake**: 49 Qbits)

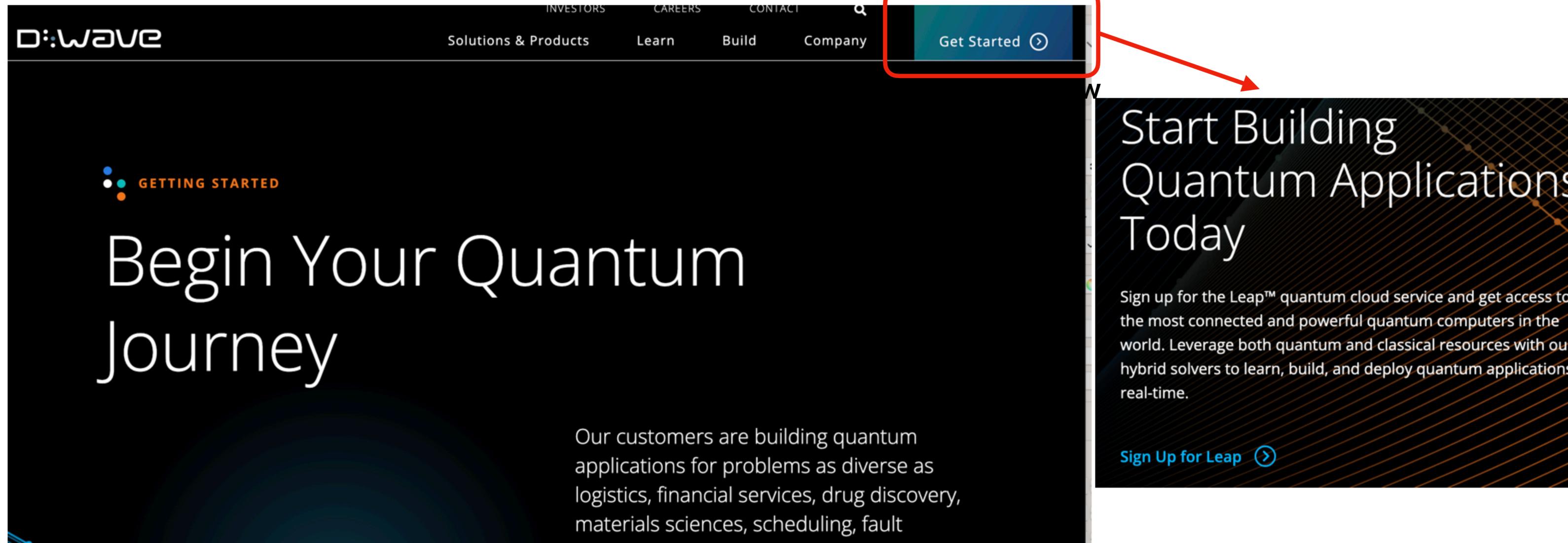
How to access D-wave quantum computer

- Go to

<https://www.dwavesys.com/build/getting-started/>

or

<https://dwavejapan.com/system/> (Japanese)



The image shows a screenshot of the D-wave website. At the top left is the 'D:WAVE' logo. The navigation bar includes 'Solutions & Products', 'Learn', 'Build', 'Company', and a 'Get Started' button with a right-pointing arrow, which is highlighted with a red box and an arrow pointing to the right. Below the navigation bar, the main content area features the text 'GETTING STARTED' in orange, followed by 'Begin Your Quantum Journey' in large white font. Below this, there is a paragraph of text: 'Our customers are building quantum applications for problems as diverse as logistics, financial services, drug discovery, materials sciences, scheduling, fault'. On the right side, there is a dark blue section with the text 'Start Building Quantum Applications Today' and a 'Sign Up for Leap' button with a right-pointing arrow.

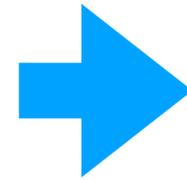
Dwave program example

 <https://github.com/dwave-examples>

 <https://youtu.be/jTDnGox0c9Y>

Play/Learn IBM quantum computer

Go to Qiskit page



<https://qiskit.org/>

Qiskit

Open-Source Quantum Development ... Qiskit [kiss-kit] is an open-source SDK for working with quantum computers at the level of pulses, circuits, and application ...

QFT — Qiskit 0.43.0 documentation

Quantum Fourier Transform Circuit. ... The circuit that implements ...

Qiskit Textbook

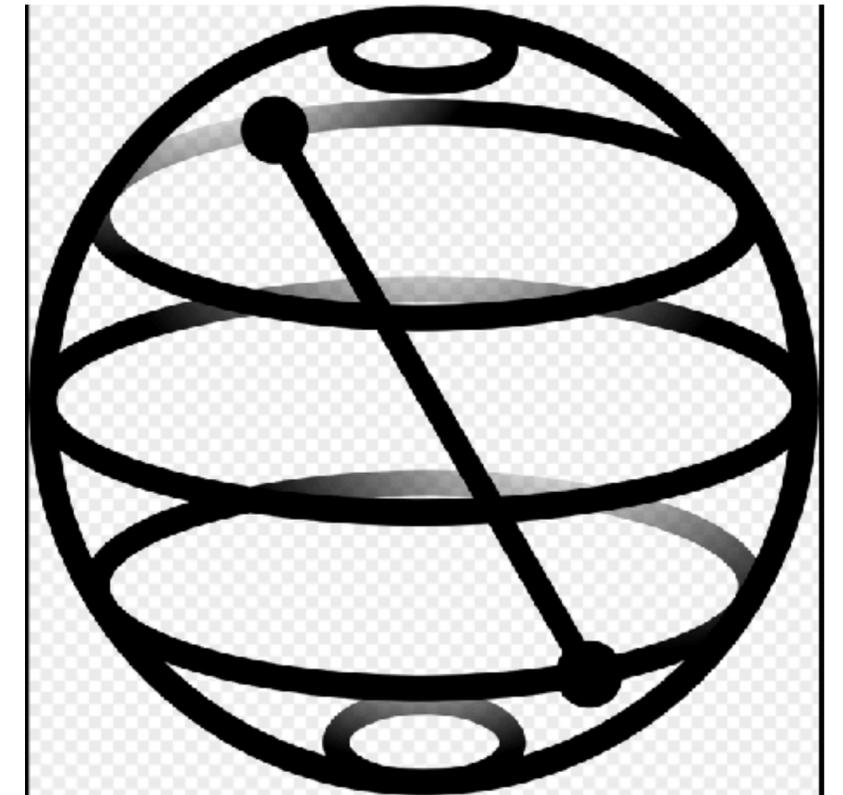
Qiskit is an open-source SDK for working with quantum ...

Qiskit 入門

Copyright IBM 2017, 2021. This code is licensed under the ...

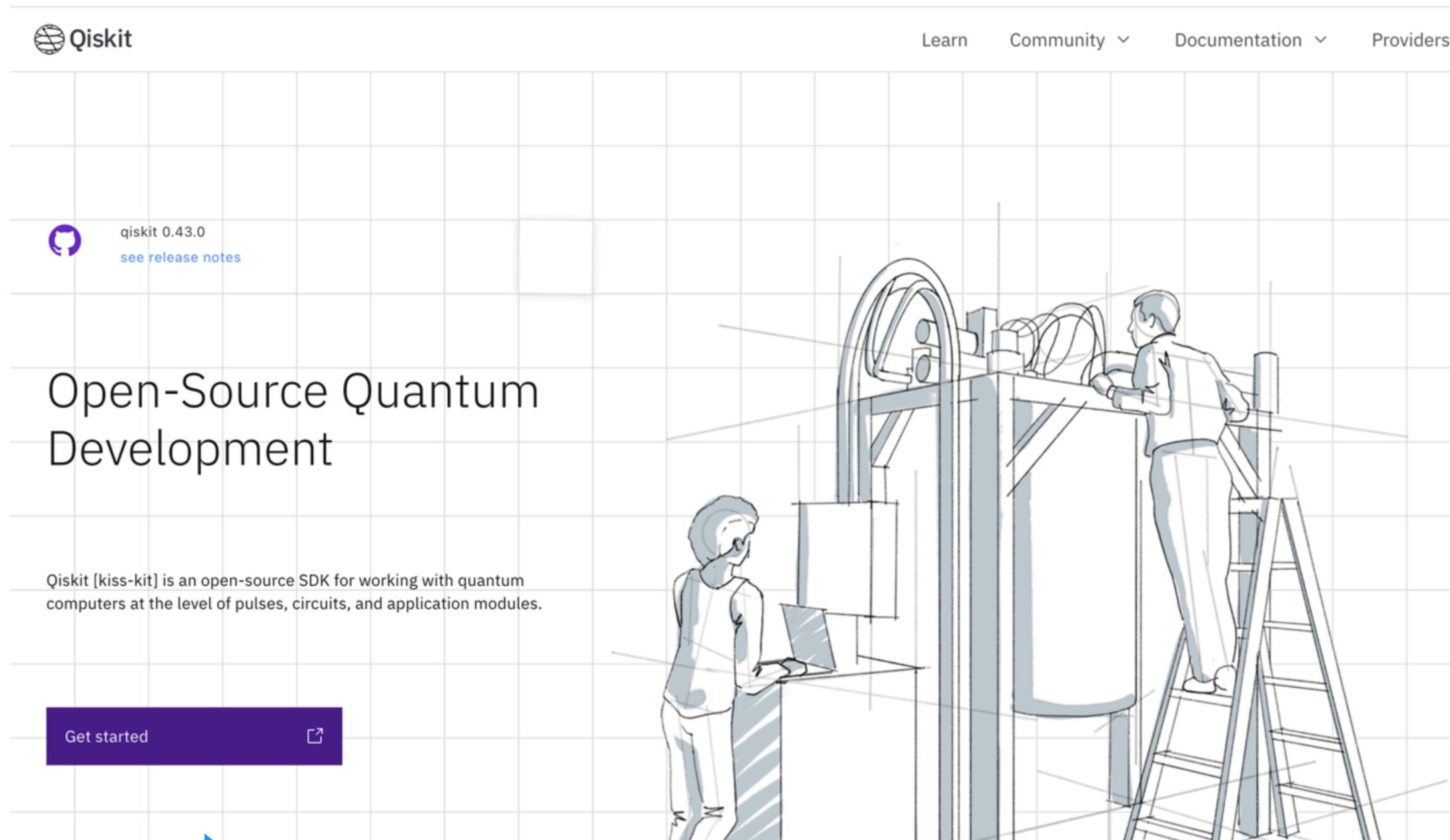
Getting started

Qiskit Aer · Qiskit IBM Quantum Provider (deprecated) ... IBM ...

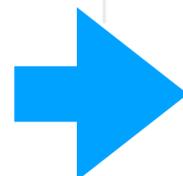


Qiskit text book

<https://qiskit.org/learn/>



Japanese
Translation



<https://ja.learn.qiskit.org/course/ch-states/the-atoms-of-computation>

Fourier transformation in Qiskit

-  <https://quantumcomputinguk.org/tutorials/quantum-fourier-transform-in-qiskit>
-  <https://ja.learn.qiskit.org/course/ch-algorithms/quantum-fourier-transform>
(Japanese version)

Good review of Entanglement ?

 John Preskill

“Quantum computing and the entanglement frontier”

arXiv:1203.5813 [quant-ph]

25th Solvay Conference on Physics, (2011)

 Etsuko Itou, Keitaro Nagata, Yoshiyuki Nakagawa, Atsushi Nakamura, V.I. Zakharov

“Entanglement in Four-Dimensional SU(3) Gauge Theory”

arXiv:1512.01334 [hep-th] (2015)

D-wave Ocean

 D-wave Ocean is the SDK (Software Developing Kit) for D-wave programming (Python).

<https://docs.ocean.dwavesys.com/en/stable/#>

https://dwavejapan.com/app/uploads/2021/04/14-1043A-A_J-Guide_Ocean_beginners.pdf

[Getting Started](#) [Concepts](#) [CLI](#) [Packages](#) [Contribute](#) [Licenses](#) [System Docs](#) [Legal](#)

D-Wave Ocean Software Documentation

Ocean software is a suite of tools [D-Wave Systems](#) provides on the [D-Wave GitHub repository](#) for solving hard problems with quantum computers.

- [Getting Started](#) shows how to install and begin using Ocean tools.
- [Concepts](#) defines and describes Ocean concepts and terminology.

Packages

The Ocean SDK includes the [CLI](#) and the following packages:

dimod — Quadratic models: BQM, DQM.

[code](#) [docs](#) 

dwavebinarycsp — Generates BQMs from constraint satisfaction problems.

[code](#) [docs](#) 

1 はじめに

D-Wave の Ocean ソフトウェア開発キット (SDK) は、ユーザーが Python プログラムを使用して D-Wave 量子処理ユニット (QPU) とハイブリッド・ソルバーにアクセスして対話することを可能にします。

本手引書の目的は Ocean の新規ユーザーと共に Ocean プログラムの基本要素の操作を1つずつ見ていくことにあります。この手引書に取り組む前に二値変数二次モデル (BQM) 入門書[1] に目を通して下さい。

ユーザーは問題に応じて BQM を定式化して、Ocean SDK を使用した Python プログラムを書き、Python プログラムを実行して返された結果をみることで D-Wave ソルバーと対話します。Python プログラムにより BQM を導入して、モデルの最小エネルギー値を見つけるために選択したソルバーに投入します。例えばソルバーが QPU の場合は、Ocean SDK は、与えられた BQM とエネルギーのランドスケープが一致するように、適切な入力データを物理的 QPU に提供します。

2 中核となる構成要素

Ocean プログラムにはいくつかの中核となる構成要素があります。まず、BQM をソルバーに提供しなければなりません。これは制約なし二次形式二値変数最適化 (QUBO) またはイジング型式で行われ