Do you have a message for the young people reading this?

It's great to work on something that interests you. On the other hand, it's important to absorb knowledge widely and voraciously because seemingly unrelated things often turn out to be connected.

The real blessing in my work is that I get to meet the very best researchers and the very best people from various companies and local governments. The common characteristics of the very best people are that they have broad perspectives and deep insights. To develop both, I think it's better not to think, "I should only study what I'm interested in."

The common characteristics of the very best people are broad perspectives and deep insights. To develop both, it's important to absorb knowledge widely and voraciously.

What is Bio2Q?

Bio2Q is a world-class research center at Keio University. It aims to use quantum computing and AI to analyze the interaction between Human Biology and Microbiome, revealing uncharted territories of the human body and developing new treatments for intractable diseases.

It is the first private university to be selected for the World Premier International Research Center Initiative (WPI) program promoted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

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wpi

Keio University Human Biology-Microbiome-Quantum Research Center (Bio2Q)

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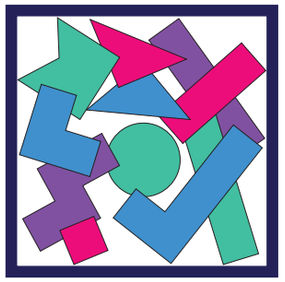
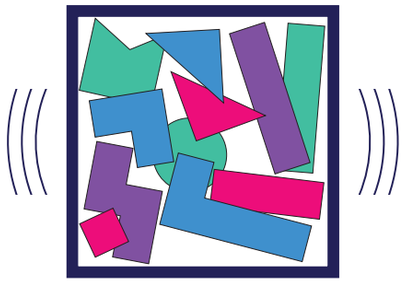
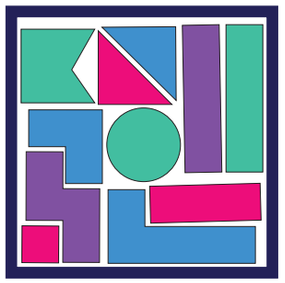
The concept of annealing



Put some building blocks into a box. The blocks will be piled up in a jumbled mess.



Shake the box (in quantum annealing, the shaking is done using quantum mechanics), and the blocks will gradually fall to the bottom.



The most blocks will be packed in (optimization of the combination of packing the blocks).

Please tell us about your research.

Quantum computing is a hot topic in various fields. In this area, we are focusing on research into quantum annealing. Quantum annealing is expected to be particularly useful for combinatorial optimization problems. In our group, members are tackling each of three themes, hardware development-related research, software research, and applications, that is, where it should be used.

What is quantum annealing?

It may be a little difficult for non-specialists to understand. In the first place, it's a bit complicated, as its name is made up of two words, 'quantum' and 'annealing.'

Here's an analogy for annealing. Imagine a box. Then, you throw some building blocks into the box. They get jumbled up and don't line up neatly. But if you shake the box, the blocks gradually fall to the bottom and come together nicely. The word 'annealing' means to make a stable structure by shaking. There is a system of physics called quantum mechanics, and quantum annealing is the use of quantum mechanics in the shaking process.

The combinatorial optimization problem I mentioned at the beginning is a problem of finding the best combination from among many possibilities. The word "optimization" is used in many different ways in the society, but it essentially means maximizing or minimizing some value. While there are many different ways of putting the blocks into the box, optimization is about packing as many blocks into the box as possible.

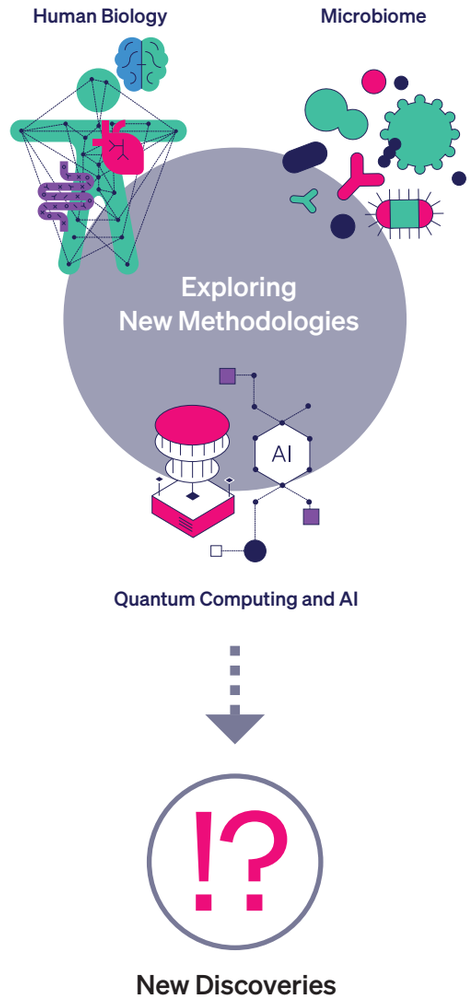
In our group, we are conducting joint research with people from various fields based on the perspective of combinatorial optimization. For example, we are researching optimization for stable structures, important for making rubber, with polymer researchers, and optimization for material exploration with materials science researchers. We are also actively conducting joint research with private companies, as well as working with the local government of Kawasaki City on initiatives for a quantum future society.

How is quantum annealing used in Bio2Q?

Bio2Q has three core units, the Bio-1 Core, the Bio-2 Core, and the Q-Core. In the Q-Core, we are researching ways to apply quantum computing and AI to the study of human biology and microbiome.

AI research is currently active around the world, with many people working on approaches to human biology using AI. In contrast, quantum computing is a newly-starting field, so the role of the Q-Core in Bio2Q is to think about how to apply quantum computing to human biology when it becomes fully established. There is a term "Quantum Ready", which refers to how we should prepare for the quantum age.

At this stage, I cannot exactly say what can be solved, but it is definitely a frontier field. For example, when hand-cranked calculators and supercomputers first appeared, who could have imagined that automatic driving would be realized in the future? In the same way, by conducting research with the expectation that there must be a methodology to apply AI and quantum computing for biology, something new and unimaginable may be born in the future. The field of "bioinformatics" uses computers to study biology. At Bio2Q, we consider that our mission is to work toward the creation of what should be called "bioquantum informatics" in the future.



The exploration of new methodologies for applying quantum computers and AI to human biology and microbiome has the potential to lead to new discoveries.

When we think of research, we tend to focus on "what has been discovered or elucidated," but it's also important to research "methodology," isn't it?

That's exactly right. To give you one important point, people tend to focus on what they can do with the existing methods. For example, before the advent of quantum computers, people tended to focus on what could be done with conventional computers, and even now, after getting a quantum computer, non-experts cannot imagine what they can do with it. That's why we need to explore new methodologies in preparation for the full-scale arrival of a new paradigm-shifting technology, the quantum computer. It's very important to break through the old methodologies, and that's what we're now working hard to achieve.

People tend to focus on what they can do with the existing methods. That's why it's important to explore new methodologies.

Since Q Core focuses on methodological exploration, our approaches and research attitudes differ from that of biologists in some respects. Something common in biology may be considered not the point in physics or information science, and vice versa. It's very interesting to learn about such different fields and cultures, and I think it's linked to my own growth.

Also, if we devise new ways to meet the biologists' desire to elucidate a problem, the very act of devising new ways can become a new research topic, which could lead to advances in computing. That is an important point.

I understand that you have been involved in a variety of research fields.

As a student, I was involved in a field of physics called statistical mechanics. After that, I did research using supercomputers, research in the field of chemistry, research in theoretical physics, and then went to the field of information science to research quantum computing. It is not that I have changed fields to advance my career, but rather that I did what I found fascinating at each stage of my life.

In my opinion, collaboration with various people, not limited to Bio2Q, can only be achieved because I have been working in various fields. It's good to master one thing, but you can't do interdisciplinary research just by that. It's important for someone like me, with experience of working in different areas, to engage in interdisciplinary research. In retrospect, I'm grateful for my career paths, given my current opportunities to collaborate with people from a wide range of fields.