


# Ultrafast combinatorial optimization based on quantum effect

Nowadays, while quantum computers gather attention, utilization of quantum annealing machines is considered for solving practical problems.

Quantum annealing machines are promising to efficiently solve “combinatorial optimization problems” where we want to find the best solution among many choices which is a hard task for conventional methods.

Combinatorial optimization problems widely exist in various business activities as shown below.

## ① Portfolio optimization

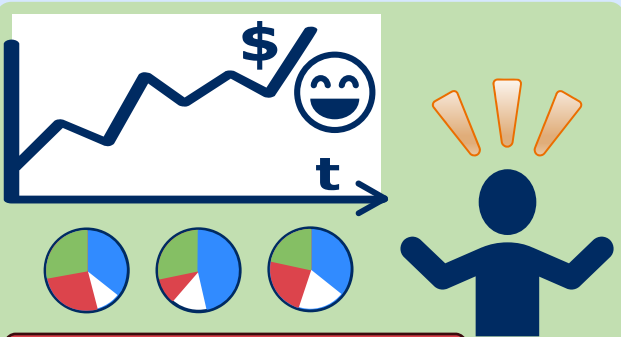


**financial**

**Finding the optimal portfolio by calculating the correlation between multiple shares.**


**Problem**  
Selecting optimal portfolio in real time is tough, because risk correlation between many stocks is not only complicated but also change in a short time.

**Solutions**  
By optimizing the investment more than 1,000 stocks in a few seconds, proper asset management is realized with maximized revenue and low risk.



**Portfolio restructuring for thousands stocks in seconds**

## ② Optimization of power/communication resource control

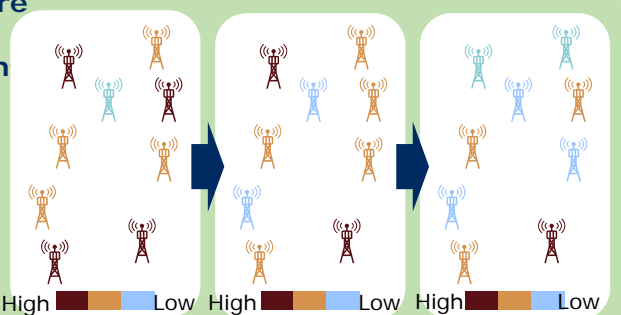


**infra**

**Optimizing social infrastructure for stable supply of energy or control of cellular base station**

**Problem**  
For stable supply and cost saving, we have to keep controlling infrastructures efficiently.

**Solutions**  
By instantaneously analyzing total power consumption or communication status of many cell phones, we can optimize transmit power, which contributes to stabilizing supply and saving cost.



**Maximization of throughput in real time by sequentially optimizing frequency and transmit power**

### ③ Optimization of traffic volume and transportation route

**Deriving the best route for logistics or autonomous driving from ever-changing traffic condition.**

**Problem**  
Traffic congestion will frequently occur, if every car runs on the same shortest path guided by a navigation system.

**Solutions**  
Traffic congestion is mitigated by providing the optimal route for each vehicle derived from traffic conditions in real time.

**Before**      **After**

**Reduced total moving cost by mitigating traffic congestion**

### ④ Advertising optimization

**Realizing optimal advertisement and recommendation depending on the user attribute where enormous patterns exist.**

**Problem**  
We have to analyze a huge amount of information for very accurate demand forecasting required for online advertising.

**Solutions**  
By calculating huge combination of user attribution efficiently, we realize appropriate advertising with high accuracy.

**Ad suitable for act.G**

**Ad DB**

**Optimized display of ad based on user action**

### How the quantum annealing machine finds the optimal solution

<div style="border: 1px solid black; padding: 5px; background-color: #ADD8E6; display: inline-block;"><b>Conventional computer</b></div> <p>Calculating each combination pattern one by one to find the optimal solution</p> <p>00000000 01011011 10111010 11111111</p> <p>Compute past the optimal solution</p> <p><b>Optimal solution</b></p>	<div style="border: 1px solid black; padding: 5px; background-color: #F08080; display: inline-block;"><b>Quantum annealing machine</b></div> <p>The system gradually changes from the quantum superposition of all combinations to the state for the optimal solution</p> <p>00000000 01011011 10111010 10111010</p> <p><b>Optimal solution</b></p>
---	---