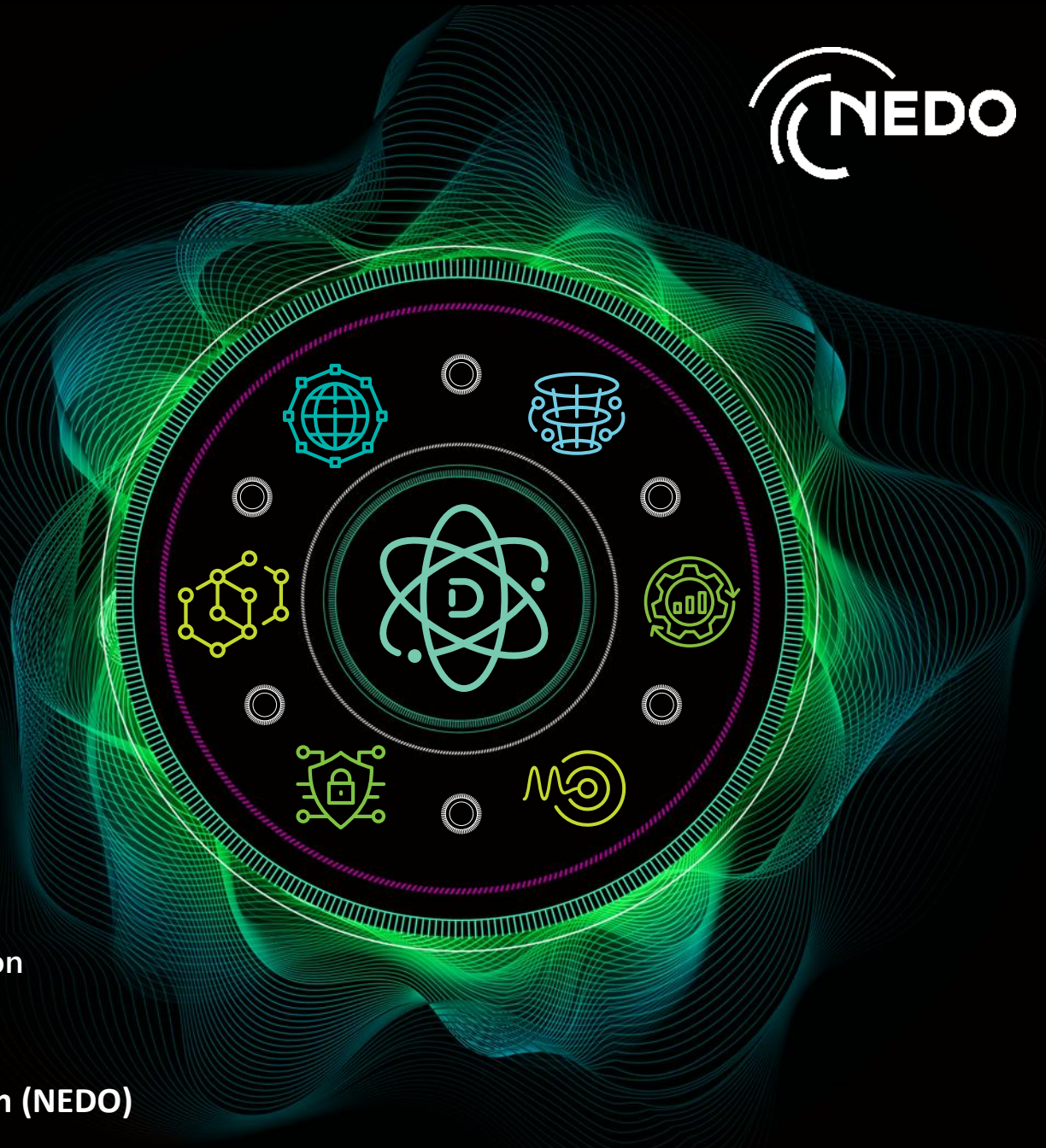
Quantum Computing Use Cases

The science of deliciousness and nutrition acquisition



Promotion of SDGs with Quantum Technology

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New Energy and Industrial Technology Development Organization (NEDO)

おいしさ・栄養獲得のサイエンス
The science of deliciousness and nutrition acquisition



ユースケース概要 **Use Case Overview**	栄養バランスを満たすため食糧範囲を拡大し、身近な食材で飢餓問題を解決 Expand the range of food to meet nutritional balance and solve hunger issues with readily available ingredients.
解決できる課題と効果 **Issues to be addressed and their effects**	10年間で1,587万人を救済し、飢餓問題を根本的に解決 In 10 years, 15.87 million people were rescued, fundamentally solving the hunger problem.
量子技術の貢献 **Contributions of quantum technology**	5大栄養素獲得のための腸内環境における分子動力学シミュレーション Molecular dynamics simulation of the intestinal environment for the acquisition of the five major nutrients.

実現予想時期 **Expected realization period**	(Year)2035～2040
産業分類 **Industry classification**	コンシューマ・その他 Consumer・Others
関連するQRAMI階層 **Related QRAMI layers**	事業層 Business layer
関連する量子技術 **Related quantum technologies**	量子コンピュータ(FTQC) Quantum Computer(FTQC)

新規性 **Novelty**	大きな革新 Significant innovation
達成難易度 **Difficulty of achievement**	困難 Difficult
社会貢献度 **Social contribution level**	社会全体に貢献 Contributions to society as a whole
市場規模 **Market size**	見積困難 Difficult to estimate

Detail

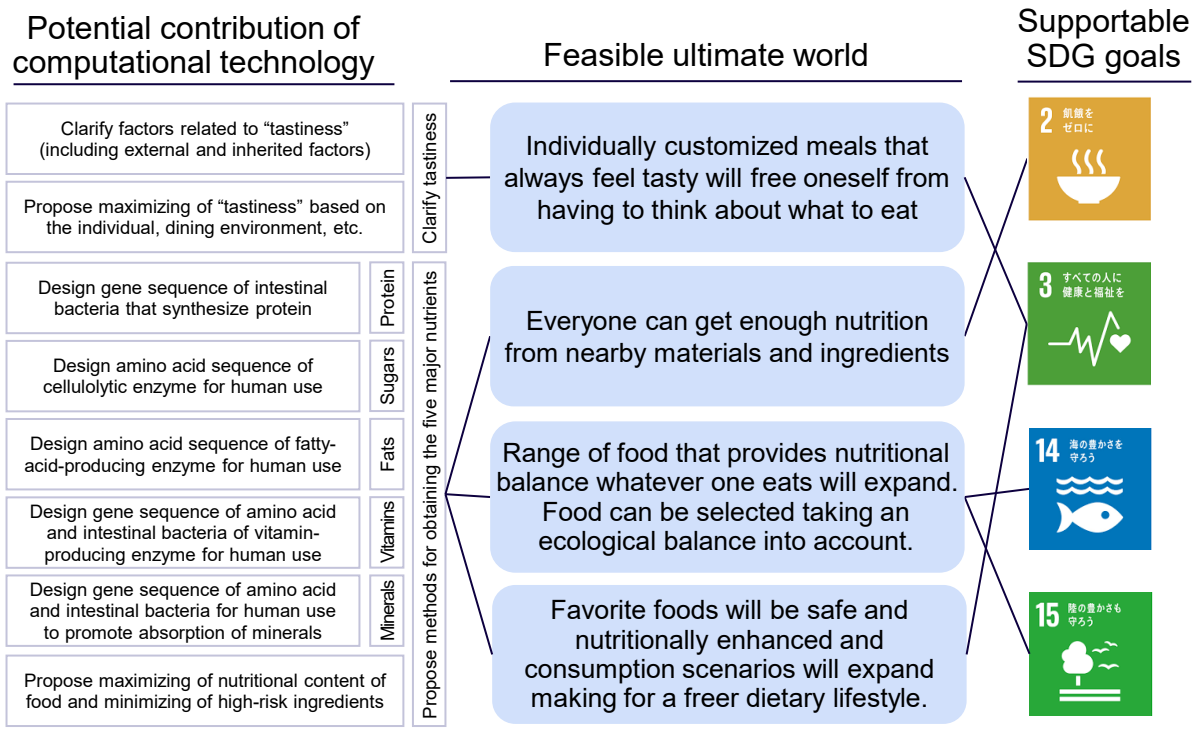
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- Sciences for creating tasty and nutritious food are progressing so that food can help everyone be happy.



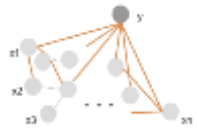
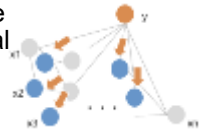
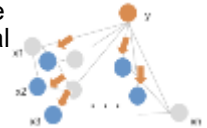
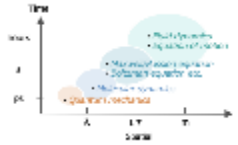
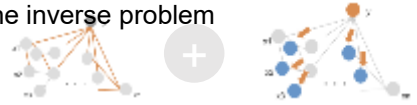
15.87 million people
Problem of hunger can be solved in 10 years

Conventional techniques can never save more than 12.4 million people, but use of quantum computers can cumulatively increase the number of people that can be saved. In ten years time, 15.87 million people can be saved and even more later enabling the problem of hunger to be basically solved.



Roadmap

The science of deliciousness and nutrition acquisition

Process		Necessary R&D and business development	Quantum-computer scope of contribution and future development issues	
Tastiness science	Construct “tastiness” model	■ Create a model of external and inherited factors related to “tastiness” (sense of smell, taste genes, etc.). Specifically, extract more parameters, apply linear analysis to a large-scale dataset with many people, optimize the function, etc.		■ Expand the scope of applying quantum computers to statistical analysis including linear regression analysis (develop techniques to expand the application range beyond existing algorithms)
	Establish tastiness production technology (to B)	■ Optimize ingredients and processing for generating a personal “This is delicious!” reaction based on differences in tastiness-related genes and external environment on an individual level. ■ Construct production/provision systems for optimal personalized recipes based on the individual’s body, dining environment, etc.	Solve the inverse problem in causal models 	■ Accelerate optimal-solution searching and expand base (develop techniques to expand the application range beyond existing algorithms)
	Establish tastiness provision technology (to C)	■ Present a method for making food taste better at any time for every individual based on the above model. ■ Develop a scheme that accesses the above simulation/method presentations from many edges and provides them as a total solution.	Solve the inverse problem in causal models 	■ Accelerate optimal-solution searching ■ Perform real-time, mass execution of established mathematical models
Nutrition science	Renovate methods for obtaining the five major nutrients Develop solutions	■ Design intestinal bacteria and enzymes for obtaining the five major nutrients. Specifically, develop precise/high-speed quantum chemical calculations and molecular dynamics simulations ➢ Protein (design gene sequence of intestinal bacteria that can synthesize protein from nitrogen in the air), sugars (design amino acid sequence of enzymes so that sugars can be consumed from cellulose), fats (design amino acid sequence of enzymes so that facts can be consumed from sugars), vitamins (design amino acid sequence of enzymes and gene sequence of intestinal bacteria that can synthesize vitamin substances), minerals (design amino acid sequence of enzymes and gene sequence of intestinal bacteria to promote absorption of minerals) * Although microorganisms themselves are easy to reproduce, there are difficulties in simulating the intestinal environment with a large number of bacteria. There is also the risk of impacting the natural ecosphere if such bacteria should be metabolically excreted from the human body.		■ Accelerate quantum chemical calculations ■ Developing algorithms to solve MD equations quickly
	Construct food-nutrient manipulation technology	■ Develop technologies for eliminating and providing alternatives to high-risk food ingredients and technology for adding nutrients (achieve a world in which everyone can get enough nutrition even if they only eat their favorite foods). Specifically, construct a biological model (story (3)) and identify high-risk ingredients based on that model.	Construct a causal model and solve the inverse problem 	■ Accelerate optimal-solution searching and expand base

Roadmap

The science of deliciousness and nutrition acquisition

Process		Necessary steps	2024	2025-2030	2030-2040	Beyond 2040
Tastiness science	Construct “tastiness” model	■ Establish evaluation criteria for “tastiness.” Analyze feasible parameter elements and establish a model foundation.				
		■ Collect sensory-evaluation data by having a large population of people wear sensors, collecting food samples, etc.				
		■ Expand the scope of applying quantum computers to statistical analysis including linear regression analysis				
		■ Identify and refine a “tastiness” function through linear regression analysis on a quantum computer				
	Establish tastiness production technology (to B)	■ Verify the feasibility and business potential of accelerating calculations using quantum computers				
		■ Accelerate optimal-solution searching and expand base (develop techniques to expand the application range beyond existing algorithms)				
		■ Develop optimal-search solution combining “tastiness” function and quantum computing				
		■ Construct production/provision systems for optimal personalized recipes				
	Establish tastiness provision technology (to C)	■ Verify the feasibility and business potential of accelerating calculations using quantum computers				
		■ Accelerate optimal-solution searching				
		■ Develop optimal-search solution combining “tastiness” function and quantum computing				
		■ Perform real-time, mass execution of established mathematical models				
Nutrition science	Renovate methods for obtaining the five major nutrients Develop solutions	■ Verify the feasibility and business potential of renovating methods for obtaining the five major nutrients using said enzymes and intestinal bacteria				
		■ Accelerate quantum chemical calculations				
		■ Develop algorithms to solve molecular dynamics equations at high speed				
		■ Develop bacteria/enzyme design optimization algorithms				
		■ Develop algorithm for predicting impact on the human body and natural world based on biological and ecological models (stories (3) and (8)) and verify safety				
		■ Establish methods for mass production and provision of intestinal bacteria and enzymes				
	Construct food-nutrient manipulation technology	■ Verify the feasibility and business potential of food-nutrient manipulation technology				
		■ Construct food-nutrient manipulation technology				
		■ Accelerate optimal-solution searching and expand base				
		■ Develop solution combining food-nutrient optimization algorithm and quantum computing				
		■ Establish methods for mass production and provision of nutrient-manipulated food				

Items related to quantum computers

More use cases are available on our website. We invite you to explore them.
https://www.quantum-computing-use-cases.nedo.go.jp/english/

More Use Cases

New Energy and Industrial Technology Development Organization (NEDO)
AI and Robotics Department (e-mail: quantum_ai@ml.nedo.go.jp)

This collection of use cases was obtained as a result of the work commissioned by the New Energy and Industrial Technology Development Organization (NEDO) "Cyber-Physical Development Business of Quantum/Classical Hybrid Technology/Study of Use Case of Quantum Technology" and the “Post-5G Information and Communications System Infrastructure Reinforcement R & D Project (Quantum Industrialization)/Comprehensive Study for Promoting the Industrialization of Quantum Computers ”.