NEDO Challenge, Quantum Computing “Solve Social Issues !”

2025,Aug

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AI・ロボット部

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p.	ID	Title ※Ctrl+Click to jump to the issue text.	Purpose	Keywords
10	S-1	Optimization of Power Transmission and Distribution Networks	Optimization of energy	Power transmission and distribution networks, distributed power sources, quantum optimization
11	S-2	Optimization of Solar Panel Placement and Exploration of Solar Cell Materials for Improving Power Generation	Optimization of energy	Perovskite solar cells, exploration of solar cell materials, sustainable energy, structural simulation, quantum machine learning
12	S-3	Reduction of Greenhouse Gas Emissions and Realization of Circular Economy Through Optimization of Energy Supply and Demand	Optimization of energy	Circular economy, energy supply-demand balance forecasting, multi-objective optimization, quantum machine learning, quantum optimization
13	S-4	Verification of Practical Application of Quantum Algorithms to CAE	Realization of advanced manufacturing	Manufacturing industry, CAE (Computer-Aided Engineering), fluid computation, encoding-decoding methods, quantum optimization, quantum machine learning
14	S-5	Application of Quantum Computers to Robot Control	Realization of advanced manufacturing	Robot control, robot path optimization, robot motion optimization, sensors, quantum optimization
15	S-6	Optimal Allocation System for Medical Resources and Human Resources During Large-Scale Disasters	Optimization of post-disaster response	Disaster prevention, pandemic, medical resources, human resources, reduction of healthcare collapse risk, quantum optimization
16	S-7	Optimal Rescue and Evacuation Route Simulation During Disasters	Optimization of post-disaster response	Disaster prevention models, improvement of life-saving rates, multimodal data analysis, quantum optimization, quantum machine learning
17	S-8	Pre-Detection of Disasters, Disaster Prediction Simulation	Optimization of post-disaster response	Disaster response, resilience, simulation of disaster damage, meteorological data, quantum machine learning
18	S-9	Improvement of Supply Chain Resilience	Enhancing resilience	Supply chain optimization, disaster and disruption response, reduction of environmental impact, quantum optimization
19	S-10	Development of Large-Scale Flight Management Technology for Next-Generation Air Mobility Unmanned Aircraft	Realization of a society with next-generation mobility	Next-generation air mobility (aviation), unmanned aerial vehicles, optimization of flight schedules, quantum optimization, quantum machine learning
20	S-11	Cost Reduction and Environmental Impact Reduction Through Optimization of Logistics Routes	Optimization of logistics	Logistics industry, optimization of delivery routes, avoidance of traffic congestion, reduction of environmental impact, quantum optimization, quantum machine learning
21	S-12	Optimization and Safety Assurance of Transportation Systems	Optimization of transportation networks	Social infrastructure, positioning and measurement systems, optimization of transportation systems, quantum optimization, quantum machine learning

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22	S-13	Process Clarification of Pollutant Photodecomposition Using Quantum Computer Simulation	Improvement of environmental pollution	Pollutants, PFAS, accumulation of trace pharmaceuticals, photocatalyst design, improvement of environmental impact, quantum optimization
23	S-14	Improvement of Network System Quality	Improvement of network quality	IT infrastructure, security enhancement, anomaly detection AI model, quantum federated learning
24	S-15	Construction of WEB3.0 Token Economy and Next-Generation Blockchain Technology Adapted to Quantum Computer Era	Realization of next-generation blockchain technology	Web3.0, tokens, blockchain, quantum machine learning, encryption technology
25	S-16	AI Quantum-Computing Scientist	Research on quantum computers using AI	AI for Science, LLM (Large Language Model), quantum-assisted engineering
26	S-17	Optimization Technologies for Automotive Structural Design that Contribute to Carbon Neutrality	Realization of advanced manufacturing	Quantum optimization, quantum machine learning, automotive structural design, multi-objective optimization
27	S-18	Real-time Computation of Financial Product Pricing and Risk using Quantum Technologies	Realization of advanced finance	Quantum optimization, quantum machine learning, financial risk, forecasting of financial risk and option price distributions

QoL

p.	ID	Title ※Ctrl+Click to jump to the issue text.	Purpose	Keywords
29	Q-1	Simulation of Disease Evolution and Pathogenesis Progress Considering Biological Diversity (Individuals, Cells, etc.)	Elucidation of disease mechanisms	Disease, simulation of disease progression, treatment strategy, quantum machine learning
30	Q-2	Development of Medical Data Sharing Applications and Algorithms to Strengthen Drug Discovery Ecosystem	Establishment of drug discovery methods	Medical quality, drug treatment data, clinical trial strategy, quantum machine learning, quantum optimization
31	Q-3	Utilization of Quantum Computers for Drug Discovery for Diseases Without Effective Treatments	Establishment of drug discovery methods	Rare diseases, personalized medicine infrastructure, quantum machine learning, quantum optimization
32	Q-4	Intellectual Activity Support Using Quantum Computers	Medical treatment	BMI (Brain Machine Interface), intellectual developmental disorder, pediatric dementia patients, autism brain model, social consensus, quantum optimization, quantum machine learning
33	Q-5	Development of Ultra-High-Speed Biological Information Analysis Methods	Medical treatment	Genetic analysis, DNA sequencing, quantum machine learning
34	Q-6	Development of Quantum Computing Algorithms for Designing Treatment Protocols for Multi-Drug-Resistant Infections	Medical treatment	Drug selection, antibiotic resistance (MDRO), treatment of bacterial infections, reduction of infection risk, quantum optimization, quantum simulation
35	Q-7	Development of Privacy-Protective Medical Data Integration Methods Using Quantum Federated Learning	Development of medical data integration methods	Personalized medicine, rare diseases, factor diseases, protection of privacy, quantum federated learning
36	Q-8	Construction of Optimal Visiting Nursing System	Optimization of resource allocation in healthcare	Home nursing, resource allocation for nursing tasks, nursing demand forecasting, quality improvement of nursing services, social consensus, quantum machine learning
37	Q-9	Development of Next-Generation Menu Planning System Using Quantum Technology	Optimization of nutrition	Personalized nutrition management, nutritional management system, extraction of preference patterns, forecasting model for food leftovers data, quantum machine learning

QoL

p.	ID	Title ※Ctrl+Click to jump to the issue text.	Purpose	Keywords
38	Q-10	Machine Generation of Interactive Educational Materials and Learning Policies (Including Test Questions for Ability Measurement) Using Quantum Computers	Provision of personalized education	Education, update of educational content, creation of personalized learning materials, quantum machine learning, quantum optimization
39	Q-11	Understanding Personality Using Quantum Computers and AI	Understanding of personality	Datafication of memory, experiential learning, treatment of memory disorders, social consensus, confidentiality algorithm
40	Q-12	Life Simulation and Well-Being Improvement Using Quantum Technology	Optimization of life indicators such as assets and health	QoL (Quality of Life) evaluation, life activity workforce, optimization of behavior measurement, quantum machine learning, quantum optimization
41	Q-13	Development of Crystal Structure Prediction System for Organic Molecules using Simulation for Optimizing Atomic Spatial Configurations	Establishment of drug discovery methods	Quantum optimization, simulation using quantum computers, crystal structure prediction, drug development, drug discovery

Cool Japan

p.	ID	Title ※Ctrl+Click to jump to the issue text.	**Purpose**	**Keywords**
43	C-1	Consideration of Innovative Game Systems Using Quantum Computers	Realization of next-generation games	Game industry, cheat prevention, quantum entanglement, quantum superposition, quantum mechanics education
44	C-2	Game Balance Optimization Using Quantum Computers	Optimization of game production	Online games, cheating behavior, data tampering, theft, anomaly detection of players, enhancement of player experience, quantum machine learning
45	C-3	Quantum-Based Cross-Media Content Optimization Engine	Manga and anime	Content market, cross-media anime, family, use of religious culture, quantum optimization, quantum machine learning
46	C-4	Quantum Diffusion Model for Manga and Animation Production	Manga and anime	Image generation AI, creative industry, quantum machine learning, quantum diffusion model
47	C-5	Interactive Theme Park and Tourist Site Management System Using Quantum AI	Revitalization of the tourism industry	Theme park, tourist attraction, overtourism, optimization of tourist experience, acceleration of theme park operations, quantum machine learning, quantum optimization
48	C-6	Anime World Experience with Five-Sense Simulation Wearables	Reproduction of the five senses	VR/AR, five senses simulation, individualized optimization of tourist experience, quantum machine learning, quantum optimization
49	C-7	Development of "Touchable Anime" Experience Using Dynamic Tactile Reproduction Technology	Reproduction of the five senses	Entertainment industry, haptic feedback, quantum optimization, quantum machine learning
50	C-8	Realization of Quantum-Driven Cultural Experience Through Fortune-Telling Using Quantum Computers (Finding "Wabi-Sabi" and "Mono no Aware" and "Cool Japan" in NISQ)	Creation of unique Japanese culture	Fortune-telling, quantum bits, quantum mechanics education
51	C-9	Provision of New Rendering Environment	Creation of unique Japanese culture	Creative industry, lending environment, quantum optimization
52	C-10	Revival of Lost Japanese Cities Using Quantum Computers	Creation of unique Japanese culture	Transmission of cultural heritage, revenue industry, restructuring of urban structure, VR/metaverse, quantum optimization, quantum machine learning
53	C-11	Development of Matching System Using Quantum Characteristics in Nurturing Games	Creation of unique Japanese culture	Nurturing, matching, quantum optimization
54	C-12	Creation of Next-Generation Music Experience Using Quantum Technology	Creation of unique Japanese culture	Festival generation, J-POP, next-generation music experience, perceptual data analysis, quantum simulation, quantum optimization

Cool Japan

p.	ID	Title ※Ctrl+Click to jump to the issue text.	Purpose	Keywords
55	C-13	Improvement of Happiness Through Quantum Entanglement Matching App	Entertainment use of quantum properties	Matching technology, quantum affinity analysis, quantum entanglement, quantum machine learning
56	C-14	DX in Fashion Industry and Strengthening Japan's Soft Power	Demand forecasting and supply chain optimization	Fashion industry, clothing production, trend forecasting, logistics, dynamic optimization for productivity improvement, quantum machine learning, quantum optimization
57	C-15	Optimization of Advertisement Location Selection: Overcoming Human Selection Challenges and Maximizing Advertisement Effectiveness	Optimization of advertising placement	Tourism, advertising, advertisement referral effect, human mobility data, consumer behavior, quantum machine learning, quantum optimization
58	C-16	Multi-Purpose Optimization for Circular Economy in Chemical and Material Industries Using Quantum Computers	Realization of a circular economy	Chemistry and materials, circular economy, Pareto front, quantum optimization

Legend & Premises

Background	This section describes the necessity of addressing the issue, the existing challenges, and the prevailing concerns within the industry.
Content	Solution applicants are required to refer to this section and consider which quantum technologies to use and how to solve the issues. This section specifies the particular challenges to be addressed, drawn from the issues identified in the background. Applicants are advised to refer to this section when considering how quantum technologies may be applied to address the specified challenges effectively. Please note that some challenge topics may list multiple issues; however, applicants are not required to address all of them. Proposals may focus solely on the items that the applicant is capable of addressing. As long as the proposed approach aligns with the general direction of the challenge and the expected outcomes, it is not necessary for the solution to perfectly match the detailed description of the issues provided. Meanwhile, please note that this prize-based program is intended to support research and development of quantum software and applications. Research and development of quantum hardware is not within the scope of this initiative. However, the development of applications that utilize data generated from quantum hardware is included within the scope of eligible challenges. Applicants are kindly asked to take this into consideration when preparing their proposals.
Example of Quantum Technology	Examples of quantum technology utilization are listed, but they are not limited to these. Furthermore, the feasibility of the illustrated technologies is not guaranteed.
Expected Outcomes	The goals for solving the issues are listed. We look forward to receiving proposals that achieve this section's objectives.
Keywords	Keywords extracted from the problem statement are listed. Please refer to the keywords to find issues of interest or those close to your expertise.

The submitted issues have undergone careful review, refinement by the secretariat and experts, and are integrated and modified. We kindly ask for your understanding.

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Optimization of Power Transmission and Distribution Networks

Background	The introduction of renewable energy is expanding due to environmental issues such as global warming. The rapid proliferation of distributed power sources such as solar and wind power has complicated the power flow distribution of the network, making it difficult to manage the appropriate system configurations. The distribution system is configured to supply power from multiple routes in order to minimize power outage sections in the event of system accidents. The power supply routes are determined by switching the opening and closing states of switches, but in the distribution network with many switches, the number of combinations increases exponentially, making it difficult for existing computers to explore all combinations in real-time.
Content	The state of the power transmission and distribution network is formulated as an optimization problem. Ultimately, the objective is to reduce power losses by efficiently optimizing large-scale transmission and distribution networks using quantum computer-based optimization methods.
Example of Quantum Technology	1. Quantum Optimization In the optimization of the transmission and distribution network, problem setting is done to minimize power loss, and it is expected that optimal states of switches will be determined using quantum optimization. By utilizing the characteristics of quantum computers, it is expected to efficiently solve large-scale combinatorial problems that are challenging for classical computers.
Expected Outcomes	• Reduction of power loss through efficient optimization of large-scale transmission and distribution networks This endeavor is expected to enable the efficient management and operation of transmission and distribution networks, contributing to the realization of a sustainable energy society.
Keywords	Transmission and distribution network, distributed power source, quantum optimization

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Optimization of Solar Panel Placement and Exploration of Solar Cell Materials for Improving Power Generation

Background	In 2024, Japan's average annual temperature, the average sea surface temperature near Japan, and the global average temperature reached record highs, leading to frequent heatwaves, droughts, large-scale floods, and wildfires. The main cause of this climate change is believed to be the combustion of fossil fuels such as coal, oil, and gas, and many countries are working towards moving away from fossil-fuel-based thermal power generation. The G7 climate, energy, and environment ministers' meeting agreed on the elimination of fossil fuels by 2035. Alternatives include nuclear power, hydroelectric power, wind power, and solar power, each with its own challenges. Particularly, perovskite solar cells in solar power are noted for their lightness and enhanced performance in cloudy and overcast conditions, with Japan being able to stably supply the core materials of major components.
Content	1. Building Structure Simulation: Predict the shape of buildings to maximize power generation while reducing costs. Use conventional solar cells together with perovskite solar cells to maximize power generation at the installation site and minimize installation costs. 2. Optimization Problem: Optimize the placement of solar cells in existing buildings to ensure power generation. 3. Material Simulation: Develop an algorithm to explore materials and main battery materials that contribute to improving photoelectric conversion efficiency.
Example of Quantum Technology	1. Simulation Using Quantum Computers Quantum computers may be more efficient than classical computers in simulating specific physical systems. Structural simulations using quantum computers can be used to precisely model power generation efficiency under various environmental conditions, predicting optimal solar cell placements and building shapes. Additionally, quantum chemical calculations can be performed to accurately analyze interactions at the atomic level, promoting efficient material design by understanding the properties of new materials. 2. Quantum Optimization This may be effective in optimizing the trade-off between solar cell placement, power generation, and the cost of power generation equipment. Efficiently solving large-scale and complex optimization problems could lead to better placement strategies. 3. Quantum Machine Learning Quantum machine learning is expected to be used in the exploration of materials that improve photoelectric conversion efficiency. It is anticipated that quantum machine learning will be applied to analyze a large amount of material data and predict efficient material properties.
Expected Outcomes	• Cost reduction and maximization of power generation in the installation of solar cells on buildings • Discovery of new materials that improve photoelectric conversion efficiency Through these efforts, it is expected to promote sustainable energy use and reduce environmental impact.
Keywords	Perovskite solar cells, exploration of solar cell materials, sustainable energy, structural simulation, quantum machine learning

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Reduction of Greenhouse Gas Emissions and Realization of Circular Economy Through Optimization of Energy Supply and Demand

Background	In 2024, it is expected that the temperature will rise by more than 1.5 degrees since the industrial revolution, making global warming measures a top priority. However, there is a lack of specific quantitative indicators to maintain the climate while maintaining living standards. Therefore, it is necessary to decompose the factors causing global warming in detail and implement appropriate measures.
Content	To minimize production and energy activities that cause global warming, the following efforts are made: 1. Decomposition of causal elements: Analyze in detail the elements of production activities and energy consumption that contribute to global warming. 2. Simulation of supply-demand balance: Use quantum computers to perform simulations that optimize the supply-demand balance. 3. Realization of a circular economy: Aim for the realization of a circular economy together with an optimized supply-demand balance.
Example of Quantum Technology	1. Quantum Machine Learning Used to analyze and identify elements contributing to global warming. With quantum machine learning, quantum support vector machines, kernels, etc., large amounts of data are efficiently analyzed to quickly and accurately identify elements causing global warming. By analyzing material properties at the atomic level and promoting efficient material design, it contributes to the development of new recycling technologies and material improvements. 2. Simulation Using Quantum Computers Used for the simulation and optimization of energy supply-demand balance. Simulation using quantum computers assists in analyzing the dynamic behavior of complex systems and helps develop optimal energy management strategies. 3. Quantum Optimization Quantum optimization is expected to be used for the optimization of energy supply and consumption, resource recycling, and waste management optimization. (Reference) https://pubs.acs.org/doi/10.1021/acssuschemeng.1c0556、 https://research.ibm.com/publications/quantum-optimization-for-multi-objective-optimization
Expected Outcomes	• Clarify the causes of global warming and implement specific measures to minimize its impact on climate change • Using quantum technology to efficiently manage supply-demand balance and improve energy efficiency • Contribute to the realization of a circular economy
Keywords	Circular economy, energy supply-demand balance forecasting, multi-objective optimization, quantum machine learning, quantum optimization

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Verification of Practical Application of Quantum Algorithms to CAE

Background	In the manufacturing industry, the importance of CAE (Computer-Aided Engineering) for the development of high-quality products and environmentally conscious designs is increasing. While examples of numerical calculations using quantum computers are increasing, most of them pertain to structured grids. There is still limited application to practical unstructured grids. Quantum technology usage in fluid dynamics calculations for complex geometries is expected to be applied at a practical level in this field. Moreover, in fluid computations, visualizing all calculated meshes is not feasible, and developing methods for data exchange between quantum computers and classical computers is a critical issue.
Content	This research and development aim to realize quantum computers at a practical CAE level by: 1. Developing encoding and decoding methods for sparse structure grids (e.g., vehicle shapes) for quantum computers. (Including mesh considerations) 2. Developing algorithms that take into account flow characteristics in fluid computations. Additionally, confirming the feasibility of CAE computations using quantum computers with simulators and actual machines, and presenting issues and solutions for transitioning from simulators to actual machines.
Example of Quantum Technology	1. Simulation Using Quantum Computers It is possible to execute fluid computations using quantum grids and fluid computations that take into account flow characteristics with quantum computers. Quantum computers are believed to have the capability to simulate the dynamic behavior of large-scale and complex systems that are challenging for classical computers to process. This is expected to enable high-precision and efficient calculations in fluid analysis for complex shapes.
Expected Outcomes	• Establishment of fluid computation technology using unstructured grids with quantum computers • Efficiency and precision improvement in design processes through practical CAE computations • Advancement in the practical application of quantum technology through the development of methods for data exchange between quantum and classical systems Through these endeavors, the use of quantum technology in the field of fluid computations will progress, leading to innovations in CAE.
Keywords	Manufacturing industry, CAE (Computer-Aided Engineering), fluid computation, encoding and decoding methods, quantum optimization, quantum machine learning

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Application of Quantum Computers to Robot Control

Background	Current robot control is mainly performed using classical computers, but there are limits to their computational capabilities. Particularly, in complex environments where real-time decision-making and processing of multiple sensor data simultaneously is required, traditional approaches may not perform adequately. Utilizing quantum computers is expected to enable more advanced robot control.
Content	In this research, methods to optimize robot motion planning and control using quantum computers will be developed. 1. Optimize robot motion planning using quantum algorithms. 2. Evaluate the applicability of quantum computers for processing sensor information.
Example of Quantum Technology	1. Quantum Optimization Quantum optimization may be applied to optimize complex sensor resources in robot motion planning. This allows for the optimization of robot paths (e.g., avoiding obstacles while moving the shortest path), improving efficiency and minimizing energy consumption, which is expected to enhance decision-making. 2. Modeling Using Quantum Computers Quantum computers assist in detailed environmental modeling based on complex information obtained from sensors. Utilizing quantum computers makes it easier for robots to adapt to the environment. 3. Analysis of Robot Data Using Quantum Machine Learning By analyzing the time-series data obtained from sensors installed in robots using quantum machine learning algorithms, robots can replicate more advanced movements, potentially leading to the realization of robots in various scenarios.
Expected Outcomes	• Improvement in computational speed and accuracy: Using quantum computers is expected to significantly enhance the speed of specific computations and improve control accuracy. • Energy conservation: More efficient control algorithms reduce the energy consumption required for robot operations, enabling sustainable operations. • Realization of complex tasks: Quantum computers make complex decision-making and environmental recognition that were impossible with traditional methods possible, leading to the development of robots capable of performing more advanced tasks such as swarm control. • Exploration of new applications: Insights gained from this research hold the potential to expand the application scope of robots in various fields such as manufacturing, healthcare, and disaster response. By conducting research with this structure, it is possible to explore new applications of quantum computers and contribute to the advancement of robotic technology.
Keywords	Robots, control, robot path optimization, robot motion optimization, sensors, quantum optimization

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Optimal Allocation System for Medical Resources and Human Resources During Large-Scale Disasters

Background	In the current allocation of medical resources and disaster response (such as natural disasters and pandemics), delays in decision-making, information asymmetry, and insufficient coordination between agencies are the main challenges. This leads to loss of life-saving opportunities and uneven distribution of medical resources, increasing the risk of healthcare collapse, and affecting business activities during disasters. Particularly, efficient and rapid allocation of medical resources is crucial during disasters, and the continuation of business activities is important for the overall stability of the economy.
Content	Utilize quantum computers to develop a system for the rapid optimal allocation of medical and human resources to improve survival rates during disasters.
Example of Quantum Technology	1. Quantum Optimization Using quantum optimization, it is possible to optimize the allocation of medical and human resources. For example, it might enable the optimization of resource movement and staff reallocation between hospitals during disasters.
Expected Outcomes	• Improvement of survival rates and reduction of healthcare collapse risks • Enhanced sense of security among residents This will lead to more efficient allocation of medical and human resources, enabling rapid disaster response, and improving the quality of medical services across society, along with stabilizing the overall economy.
Keywords	Disaster prevention, pandemic, medical resources, human resources, reduction of healthcare collapse risk, quantum optimization

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Optimal Rescue and Evacuation Route Simulation During Disasters

Background	Rapid rescue activities and evacuation during disasters are crucial for minimizing human casualties and economic losses. Disasters such as earthquakes, tsunamis, and massive typhoons result in road and infrastructure destruction, debris, and flooding, hindering rescue operations and evacuation. Traditional rescue route generation systems and evacuation planning face limitations in processing capability and struggle to adapt to dynamic changes in terrain and environment. Additionally, there is insufficient individualized evacuation support for the elderly and people with disabilities.
Content	Utilize quantum computers and IoT technology to develop a system that addresses the following issues: • Model the entire disaster-affected area as a dynamic graph and generate the shortest rescue and evacuation routes • Instantly detect obstacles and impassable areas to propose alternative routes for rescue operations and evacuation • Optimize each rescue activity (saving lives, transporting goods, managing shelters) and provide optimized routes tailored to the individual needs of evacuees • Integrate time-series data from satellite data, drone footage, ground sensors, and information obtained from SNS posts to assess the progression of the disaster • Use predictions for locating people amidst collapsed buildings for rapid rescue operations
Example of Quantum Technology	1. Quantum Optimization Used for shortest route generation. Quantum optimization is employed to rapidly compute the shortest routes while considering dynamic changes in terrain and infrastructure damage during disasters. This enables simultaneous processing of numerous variables and constraints, with the expectation of generating optimal rescue and evacuation routes. For evacuation, it is possible to achieve optimal selection of shelters considering many factors like shelter capacity, traffic conditions, and individual needs of evacuees. 2. Quantum Machine Learning Quantum machine learning is used to efficiently process vast amounts of data such as barriers and impassable areas, potentially enabling accurate assessment of disaster progression. It also holds potential for efficient search and rapid rescue of lives amidst debris from collapsed buildings.
Expected Outcomes	• Acceleration and efficiency of rescue operations and evacuation during disasters lead to reduced human casualties and economic losses • Improved safety and efficiency through disaster situation assessment and adaptive route suggestions • Implementation of the fastest rescue and evacuation routes using quantum technology, contributing globally as a technological advance • Enhanced disaster response capabilities domestically and internationally, serving as a model case for disaster prevention technology This initiative is expected to strengthen disaster response, improve the survival rate, and suppress economic losses.
Keywords	Disaster prevention model, improvement of survival rate, multimodal data analysis, quantum optimization, quantum machine learning

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Pre-Detection of Disasters, Disaster Prediction Simulation

Background	Due to global warming and climate change, the frequency and scale of natural disasters are increasing. Disasters such as earthquakes, typhoons, and floods caused by heavy rain, including tunnel collapses, are leading to human casualties and economic losses. Against this background, the development of predictive technologies to prevent disasters in advance is urgently needed.
Content	1. Pre-detection and impact forecasting of building collapses Conduct pre-detection of building collapses and simulations of disaster-induced damage while considering various factors (e.g., simulations of damage in tunnels during natural disasters that account for geological information and exhaust gas). This aims to efficiently assess collapse risks and implement appropriate measures. 2. Pre-detection and impact forecasting of sporadic floods due to glacier collapse in alpine areas Utilize monitoring data from alpine areas to build a system for early detection of glacier collapse signs and perform damage simulations. 3. Forecasting climate change and its impact on typhoon route transitions, urban damage, and economic impacts Integrate meteorological data and urban infrastructure data to build a simulation method for the impact of climate change on cities. Develop simulation algorithms combining climate models with economic models to forecast changes in typhoon routes and economic losses due to flood damage.
Example of Quantum Technology	1. Quantum Machine Learning Using quantum machine learning to analyze data from sensors monitoring the state of tunnels, it is possible to construct an early warning system. This is expected to enable rapid detection of abnormal patterns and implementation of preemptive measures. Additionally, using quantum computers for simulating glacier movements and temperature changes allows for more accurate early detection of glacier collapse signs. 2. Simulation with Quantum Computers Using quantum computers for simulation can potentially lead to more accurate predictions of climate change. Furthermore, integrating meteorological data with urban infrastructure data in simulations is expected to more accurately forecast climate change impacts on typhoon route transitions, urban damage, and economic effects.
Expected Outcomes	• Improved tunnel safety and reduced accident risks • Mitigation of typhoon and flood damage • Establishment of predictive technologies contributing to sustainability measures This is expected to establish disaster prevention technology that contributes to climate change, urban planning, and economic measures.
Keywords	Disaster forecasting, resilience, simulation of disaster damage, meteorological data, quantum machine learning

Improvement of Supply Chain Resilience

Background	While optimization of supply chains is being pursued through increased efficiency in business activities, disruptions in some nodes (companies) tend to propagate across the entire chain. Shortages of pharmaceuticals, automobiles, electronic products, and rice are examples. Large-scale disasters (earthquakes, floods, pandemics) disrupt supply chains affecting many companies, making recovery difficult. Supply chains consist of multi-tier corporate transactions, and even in normal times, difficulty in visibility at some points complicates countermeasures.
Content	Model the entire supply chain to enable quantitative analysis of how disasters or company disruptions in any region can impact one's own company in advance. This allows for optimization of economic aspects (purchase price, logistics costs, delivery times, etc.) and environmental burdens (CO2 emissions, recycling ratios, etc.), and enhances fault tolerance, ensuring preparedness for disasters and disruptions and enabling rapid recovery.
Example of Quantum Technology	1. Quantum Optimization Quantum optimization may be effective for comprehensive optimization considering the economics, environmental burden, and fault tolerance of supply chains. By utilizing these algorithms, it may be possible to discover optimal procurement strategies and logistics routes while considering numerous constraints. This also holds promise for reducing the vulnerability of supply networks during disasters and contributing to the construction of sustainable supply chains.
Expected Outcomes	• Improved resilience and economic optimization of supply chains • Rapid response and recovery during disasters • Reduction of environmental burden and construction of sustainable supply chains This initiative is expected to enhance the stability of supply chains, increasing the efficiency and sustainability of business activities.
Keywords	Supply chain optimization, disaster, disruption response, reduction of environmental burden, quantum optimization

Technology for Next-Generation Air Mobility Unmanned Aircraft

Background	In advanced countries, including Japan, the social implementation of next-generation air mobility is considered a national strategy, with many companies entering the market. Realizing air mobility requires a large-scale system to control and manage both unmanned and manned aircraft. Particularly concerning unmanned aircraft, high computing speed and safe control methods are demanded for safe and efficient control. However, these requirements are not sufficiently verified at present.
Content	Utilize quantum computers to optimize the control of unmanned aircraft. Specifically, tackle large-scale unmanned aircraft flight management itself and schedule, route control, and swarm control.
Example of Quantum Technology	1. Quantum Optimization In enhancing scheduling, it is expected to discover more efficient solutions in the scheduling of unmanned aircraft and task allocation. This considers multiple flight paths and timeframes to compute optimal paths for comfortable and safe flight and avoid collisions while maintaining swarm control and avoiding collision with other aircraft. 2. Quantum Machine Learning Using quantum machine learning to analyze flight data and perform inter-species and measurement to improve safety. 3. Quantum Encryption Using data security enhancement technology through quantum computers to ensure communication safety and reduce risks of hacking and data eavesdropping for unmanned aircraft.
Expected Outcomes	• Verification of systems enabling simultaneous control of large-scale unmanned aircraft • Improved flight operation safety alongside flight efficiency • Contribution to the realization of a safe and efficient air mobility society This endeavor is expected to advance the safety and efficient operation of unmanned aircraft.
Keywords	Next-generation air mobility (aviation), unmanned aerial vehicles, optimization of flight schedules, quantum optimization, quantum machine learning

Cost Reduction and Environmental Impact Reduction Through Optimization of Logistics Routes

Background	The logistics industry is experiencing increasing delivery demand due to the expansion of the e-commerce market and population concentration in urban areas. To meet this demand, logistics operators are required to make swift deliveries while facing challenges such as rising fuel and labor costs, staff shortages, traffic congestion, and compliance with environmental regulations. Consumers demand shorter delivery times and higher accuracy, while efforts toward sustainable logistics operations are being emphasized as a social responsibility.
Content	New technologies capable of optimizing logistics routes are needed to eliminate current bottlenecks, such as inefficiencies in route design, increasing operational costs, heightened environmental burdens, and declining customer satisfaction. Aim to achieve operational efficiency and environmental burden reduction ~~through the use of~~ with quantum computers.
Example of Quantum Technology	1. Quantum Optimization Quantum optimization is expected to rapidly compute optimal delivery routes while considering multiple constraints (such as traffic conditions, delivery time, fuel cost). This can lead to reduced operational costs and shortened delivery times. 2. Quantum Machine Learning Utilize quantum machine learning technology to analyze real-time information collected from sensors and GPS data. Quantum machine learning enables rapid prediction of traffic conditions and demand fluctuations, optimizing route selection. Implementing such technology may facilitate efficient deliveries. 3. Simulation Using Quantum Computers Employ simulations using quantum computers to assess and minimize environmental impacts of energy consumption and emissions in transportation. This holds the potential to advance sustainable and optimized logistics operations.
Expected Outcomes	This initiative is expected to promote efficiency in the logistics industry while reducing environmental burdens. Specifically, it anticipates cost reduction through optimized delivery routes, improved customer satisfaction through fuel emission reduction to adapt to environmental regulations, visualization of delivery conditions, and enhanced communication reliability.
Keywords	Logistics industry, delivery route optimization, avoidance of traffic congestion, reduction of environmental burden, quantum optimization, quantum machine learning

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Optimization and Safety Assurance of Transportation Systems

Background	Effectively utilizing traffic information, including vehicle and pedestrian location data, to improve traffic congestion and accurately assess traffic accident situations is a societal challenge. By processing big data from satellites and base stations to accurately determine location data for vehicles and pedestrians using autonomous positioning systems, optimization and security enhancement of traffic systems are expected.
Content	1. Optimization of Big Data x Traffic Systems Expand existing information acquisition systems like VICS to predict future traffic congestion and provide avoidance information. Build traffic signal control strategies, exploring optimal routes based on vehicle and pedestrian information. This realizes traffic congestion control. 2. Strengthen Safety of Information on Objects Targeted by Big Data Aim to obtain and analyze data of vehicles and bicycles on a per-second basis, targeting understanding of situations such as traffic accidents.
Example of Quantum Technology	1. Quantum Optimization Using quantum optimization is expected to rapidly compute optimal traffic control strategies that consider multiple constraints like alleviating traffic congestion, routing vehicles, predicting, and adjusting traffic. This enables efficient prediction and avoidance of traffic congestion, potentially improving transport efficiency. 2. Quantum Machine Learning Utilize quantum machine learning to analyze traffic data (VICS, vehicle data, signal data). Quantum machine learning can predict traffic congestion turns and future traffic situations, proposing suitable routes for each vehicle. Moreover, using quantum support vector machines and quantum reinforcement learning on vast data from sensors to recognize traffic accidents and quickly provide information to drivers and pedestrians holds promise.
Expected Outcomes	• Efficient transportation systems reduce urban congestion and shorten travel time • Utilizing big data improves the safety of societal infrastructure This initiative, anticipating the realization of autonomous positioning systems, contributes to efficiency and security enhancement in transportation.
Keywords	Social infrastructure, positioning and measurement systems, optimization of transportation systems, quantum optimization, quantum machine learning

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Process Clarification of Pollutant Photodecomposition Using Quantum Computer Simulation

Background	The accumulation of pollutants (PFAS and trace pharmaceuticals) is recognized as a major environmental problem that needs to be resolved. These substances are difficult to degrade in the environment and require removal. Photocatalytic decomposition methods using light are widely researched, but simulations incorporating the interaction between light and substances are necessary, with limitations on simulations using classical computers.
Content	Utilize quantum computers to elucidate the mechanism of photodegradation and aim for optimal photocatalyst design. Specifically, undertake the following efforts: 1. Identify conditions under which pollutants can be efficiently photodegraded and discover efficient photodegradation conditions. 2. Discover photocatalytic reactions with superior performance compared to current photocatalysts.
Example of Quantum Technology	1. Quantum Optimization Quantum computers are expected to simulate extreme quantum states and chemical reactions with high precision, challenging for classical computers. By modeling the interaction between light and pollutants in detail, they may identify optimal photodegradation conditions (such as light wavelength, intensity, reaction time) for efficient decomposition. 2. Simulation Using Quantum Computers Understanding the mechanism of photocatalytic reactions is expected to provide clues for improving reaction efficiency. For instance, simulating quantum states of photocatalyst surfaces (interfaces) allows evaluation of the environmental effects of different photocatalysts during their design phase.
Expected Outcomes	• Improvement in environmental burden through the discovery of efficient pollutant removal methods • Technological innovation in the development of new photocatalysts This initiative is expected to contribute to a sustainable future.
Keywords	Pollutants, PFAS, accumulation of trace pharmaceuticals, photocatalyst design, improvement of environmental burden, quantum optimization

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Improvement of Network System Quality

Background	In modern IT infrastructure, the stability of communication services, software security, and network security are emphasized. Resolving challenges in these areas are required, particularly in anomaly detection, threat diagnostics, and utilizing quantum networks. Therefore, new approaches that exceed the limitations of current technology are needed.
Content	1. Anomaly Diagnosis and Forecasting Develop anomaly detection AI models that combine machine learning and natural language processing to rapidly identify anomalies in large-scale networks (including blockchain). Implement predictive processing algorithms that prevent anomalies, enabling real-time monitoring and rapid response. 2. Quantum Networks and Information Security Build a decentralized platform enabling information processing via quantum nodes integrated with classical networks, realizing secure communications through quantum technology introduction.
Example of Quantum Technology	1. Quantum Machine Learning Utilize quantum machine learning and quantum support vector machines to analyze large-scale network data, enabling rapid anomaly identification. It is expected to enhance anomaly detection AI model performance and construct predictive processing algorithms. 2. Quantum Federated Learning Develop systems that securely learn decentralized information on quantum federated learning networks, protecting data privacy while learning. Integrating with classical networks realizes secure contactless communication, potentially greatly enhancing information security.
Expected Outcomes	• Enhanced threat detection and security in IT infrastructure operation management • Improved platform security through advances in next-generation AI and IT technology It aims to solve current IT infrastructure challenges and advance the technology foundations of the future by pursuing this initiative.
Keywords	IT infrastructure, security enhancement, anomaly detection AI model, quantum optimization, quantum machine learning

Construction of WEB3.0 Token Economy and Next-Generation Blockchain Technology Adapted to Quantum Computer Era

Background	Modern economic systems are often significantly affected by exchange rate and economic fluctuations, making the creation of universally agreed-upon value a challenge. Especially in the era of Web3.0, establishing token economies aimed at new value concepts is required. Moreover, the electricity consumption necessary for transaction processing (mining, etc.) within blockchain platforms is also a concern. Furthermore, designing reliable transactions that prevent collusion among players on the blockchain is a critical issue.
Content	1. Exploration of New Token Economic Systems Develop algorithms that enhance efficiency in token distribution and circulation, realizing fair value concepts. 2. Development of Next-Generation Blockchain Technology Develop blockchain technology that is safe and energy-efficient, catering to various use cases. 3. Data Analysis for Collusion Detection Develop data analysis methods using quantum computers to detect player collusion on the blockchain.
Example of Quantum Technology	1. Quantum Machine Learning and Quantum Optimization It is expected to develop algorithms that realize fair value circulation by analyzing token distribution and consumption patterns using quantum machine learning. Additionally, by using quantum optimization to enhance the efficiency of token allocation and circulation, it is expected to optimize token usage and establish foundational support for a fair economic system. 2. New Blockchain Foundation Utilizing Quantum Computers By utilizing quantum computers for transaction processing (such as mining), it is expected to reduce electricity consumption, which is a challenge in mechanisms like PoW (Proof of Work). 3. Data Analysis Using Quantum Computers Data analysis using quantum computers is expected to analyze data structures on the blockchain and detect potential collusion among players. Moreover, blockchain network transactions can be modeled as a graph, and it is expected to identify abnormal patterns and signs of collusion using quantum algorithms.
Expected Outcomes	Establish safe and efficient blockchain technology adapted to the quantum computer era, creating new economic systems for the Web3.0 era. Furthermore, enable reliable transaction design to enhance transparency and fairness in digital trades, providing a crucial foundation for realizing Society5.0.
Keywords	Web3.0, token, blockchain, quantum machine learning, encryption technology

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AI quantum-computing Scientist

Background	Computers, invented in the 20th century, have played an essential role in accelerating science and technology, functioning as an indispensable technical foundation in society. In the early 21st century, the concept of "AI for Science," actively utilizing AI in science and engineering, was proposed, and with the development of large language models (LLM), the possibility of AI substituting research and development tasks is under discussion. Moreover, the concept of "AI Scientist" as an agent automating a series of research processes, including generating new research ideas, writing code, conducting experiments, evaluating results, authoring papers, and reviewing, has also been proposed (Reference) https://arxiv.org/abs/2408.06292 On the other hand, quantum computers (quantum computing systems) inherently possess different computational capabilities, with societal applications anticipated. Therefore, methodologies combining quantum computers and LLMs, such as quantum engineering (Quantum CAE), and Quantum Optimization Envelopes (QOE) automating quantum algorithm optimization, are being developed
Content	1. This issue aims to build a research and development platform integrating quantum computers and AI technology. Specifically, based on the concept of AI Scientist, develop an AI quantum-computing Scientist to automatically conduct quantum software research, and propose methodologies for more general quantum algorithm and software research and development. Note that the scope of research and development targeted by AI Scientist includes the entire research process, from idea generation to review, as described in the background. Additionally, proposals focusing on part of this process are also acceptable.
Example of Quantum Technology	1. Quantum Machine Learning Utilizing quantum machine learning can accelerate necessary data analysis for quantum algorithm development and optimization, potentially enhancing the performance of AI Scientists 2. Quantum Optimization The AI quantum-computing Scientist might use quantum optimization for optimal resource allocation and experimental conditions in research and development.
Expected Outcomes	This project is expected to establish an innovative research and development platform through the integration of quantum computers and AI. Realizing the AI quantum-computing Scientist is anticipated to enhance the efficiency of quantum algorithm and software research and development, facilitating further acceleration in science and technology. Consequently, it is expected to promote the practical application of quantum computers and their societal contributions, strengthening the scientific and technological foundations of the next generation
Keywords	AI for Science, LLM, quantum-assisted engineering

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Optimization Technologies for Automotive Structural Design that Contribute to Carbon Neutrality

Background	To address environmental issues such as global warming, achieving carbon neutrality has become a critical challenge in the automotive industry. There is a worldwide demand for weight reduction in car body structures, as it has a significant impact on emissions during development, production, and driving. However, due to the globalization of markets and the diversification of customer needs, it has become increasingly difficult to balance weight reduction with meeting customer demands.
Content	This issue aims to solve the problem of vehicle body structure weight reduction by utilizing multi-objective optimization techniques while satisfying the required constraints. The problem is formulated as a multi-objective optimization problem with a large number of variables and numerous constraints. Conventional combinations of computers and optimization methods require an enormous number of trials, resulting in increased computational costs and difficulties in reducing CO_2 emissions during the development period. Therefore, methods using quantum computers to efficiently identify optimal solutions are being pursued.
Example of Quantum Technology	1. Quantum Optimization Quantum computing allows for the efficient solving of combinatorial optimization problems. This approach is particularly effective in handling large-scale variables and constraints in multi-objective optimization problems, and is expected to perform complex calculations in a short time that are difficult for conventional computers. 2. Quantum Machine Learning By leveraging the expressive power of quantum bits in quantum computers, rapid data analysis and pattern recognition become possible. In the context of automotive structural design, it is expected that optimization for weight reduction can be advanced based on historical data.
Expected Outcomes	By utilizing quantum computers, it becomes possible to efficiently solve multi-objective optimization problems with large-scale variables and numerous constraints—challenges that have been difficult to address using conventional methods. This is expected to enable the simultaneous achievement of vehicle body weight reduction and customer satisfaction, thereby opening a new path toward more sustainable automotive development in pursuit of carbon neutrality. Ultimately, the goal is to significantly reduce development costs and CO2 emissions.
Keywords	Quantum optimization, quantum machine learning, automotive structural design, multi-objective optimization

Real-time Computation of Financial Product Pricing and Risk using Quantum Technologies

Background	In financial institutions, a vast amount of computation is required daily, particularly for calculations related to options, risk indicators, and pricing adjustments, which play a critical role. These calculations are based on stochastic differential equations and generally lack analytical solutions, leading to the widespread use of probabilistic methods. However, such methods require an extremely large number of samples, making it difficult to reference and update calculations when input parameters fluctuate during open market hours. Current methods struggle to maintain accuracy in real-time.
Content	This issue aims to achieve the following objectives by applying probabilistic methods enhanced using quantum computing. ・The realization of algorithms that enable real-time option pricing and risk metrics in response to intraday market fluctuations, such as changes in stock prices and volatility. ・The realization of a forecasting function for future option price distributions, based on scenarios involving interest rates and economic conditions. In addition to achieving the above objectives, this issue also pursues the following initiatives. ・Verification of the superiority over models actually used in financial institutions, through simulations and physical implementations. ・Proposal of a novel computational architecture that integrates multiple technologies—for example, generating future scenarios using machine learning, while accelerating pricing computations through quantum computing.
Example of Quantum Technology	1. Quantum Optimization By applying quantum optimization algorithms to financial problems such as risk calculation and portfolio optimization, it is expected that solutions can be derived more efficiently than with existing algorithms. 2. Simulation Using Quantum Computers This approach allows for solutions to be derived with fewer data points compared to conventional probabilistic methods. Theoretically, it is expected to significantly improve computational speed and reduce processing time. Due to this characteristic, it may become practically feasible to conduct analysis and evaluation with less computational cost than traditional methods. 3. Quantum Machine Learning It is expected that adaptive models and neural networks will be able to learn and be evaluated more rapidly. As a result, option pricing functions can be assessed and updated more quickly. 4. Quantum Random Walk Simulating stochastic processes using this approach may offer more efficient computation than classical random walks. As a result, it is expected to enable faster simulation-based evaluations in financial derivative pricing and risk analysis.
Expected Outcomes	Financial institutions are expected to be able to efficiently reference and update option prices and risk metrics in real time, particularly improving performance during market hours. Through the application of quantum technologies and machine learning, it is anticipated that calculation times can be reduced while achieving more accurate pricing and risk management, thereby contributing to enhanced operational efficiency in financial institutions.
Keywords	Quantum optimization, quantum machine learning, financial risk, forecasting of financial risk and option price distributions

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Simulation of Disease Evolution and Pathogenesis Progress Considering Biological Diversity (Individuals, Cells, etc.)

Background	Simulating the progress of health-harming phenomena (such as cancer progression and the spread of infections within the body) is believed to aid in enhancing the understanding of pathology and developing new treatment strategies. However, due to the interaction of numerous factors such as genetic mutations and intercellular interactions, modeling these changes is highly complex. This complexity makes computation difficult for classical computers.
Content	Utilize quantum computers to develop methods for simulating disease onset mechanisms. This simulation aims to understand various health-harming phenomena that were challenging for classical computations and establish new treatment strategies.
Example of Quantum Technology	1. Simulation Using Quantum Computers Quantum computer-based simulations might elucidate complex molecular interactions within cells. This could provide insights into cancer cell evolution patterns and mechanisms, as well as infection spread, leading to the formulation of new treatment strategies. 2. Quantum Machine Learning Applying quantum machine learning to large datasets obtained from research could uncover patterns and characteristics that are difficult to identify with conventional methods. This might lead to identifying key factors associated with disease onset, including tumors, and gaining new insights for deeper understanding of mechanisms. 3. State Modeling Using Quantum Computers State modeling using quantum computers offers a new approach. For example, it may be possible to explore probabilistic scenarios of cancer evolution and predict how cancer might evolve.
Expected Outcomes	• Realization of cancer evolution simulation using quantum computers • Development of new treatment strategies based on disease models This issue anticipates unveiling new possibilities in treatments.
Keywords	Disease, simulation of disease progression, treatment strategy, quantum machine learning

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Development of Medical Data Sharing Applications and Algorithms to Strengthen Drug Discovery Ecosystem

Background	In pharmaceutical development, the prolonged development periods and rising costs have become serious concerns. Drug treatment data (including clinical trial data) are isolated within companies and research institutions, making mutual utilization difficult and causing inefficiencies in research progress and patient recruitment. Furthermore, inadequate sharing of valuable drug treatment data results in limited learning effects, leading to significant opportunity losses in improving development success rates. The Japanese government seeks open innovation foundations encompassing "pharmaceutical ecosystem enhancement," including data and operational openness.
Content	This project will develop algorithms that enable safe and equitable sharing of drug treatment data. Utilize quantum computers to enhance cutting-edge analytical techniques for solving complex treatment design problems and multidimensional data analysis. This promotes the efficient utilization of data among pharmaceutical companies, academia, CROs, and regulatory authorities, aiming for enhanced efficiency and success rates in the pharmaceutical ecosystem.
Example of Quantum Technology	1. Quantum Machine Learning Leverage machine learning utilizing quantum computers to analyze extensive drug treatment data, including safety indicators, efficacy indicators, patient background information, and failure data. By discovering biomarkers and correlations that are difficult to extract and predict using conventional methods, it is expected to strengthen the drug discovery process for new drug candidate substances. 2. Quantum Optimization Utilize optimization methods such as quantum algorithms to explore patient selection, dosing schedules, combination medications, etc., in clinical trials. This aims to improve clinical trial success rates and cost efficiency. 3. Enhancing Data Security with Quantum Technology Ensure data exchange security by using quantum technology in the sharing of drug treatment data. This makes data sharing between companies and research institutions more reliable. Provide security that can adapt to various analysis processes, enhancing mutual data utilization and promoting open innovation communities.
Expected Outcomes	This project is expected to shorten clinical trial durations and reduce development costs through data sharing and utilization of advanced technologies. Additionally, enhancing the international competitiveness of the pharmaceutical industry by utilizing vast data for model generation. Further, through the implementation of cutting-edge drug discovery development, a sustainable ecosystem is formed, contributing to the elevation of Japan's standards and models internationally.
Keywords	Pharmaceutical development, drug treatment data, clinical trial strategy, quantum machine learning, quantum optimization

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Utilization of Quantum Computers for Drug Discovery for Diseases Without Effective Treatments

Background	The development of new treatments for patients with no effective treatment options presents long-term challenges. As a result, patients are unable to secure efficient treatment choices, leading to societal issues with designer drug crossovers proliferating. For example, infants and toddlers experience new side effects associated with physiological factor variables during growth or chemical conversion media in joints, severely restricting social labor environments regarding patients' QOL and life expectancy. The government prioritizes improving medical access in areas of rare diseases and pediatric-adult domains, emphasizing the establishment of individualized medical engagement with advanced technologies.
Content	This issue aims to build an individualized medical foundation by integrating genome analysis and clinical data for diseases lacking effective treatments. Utilize quantum computers and AI analytical technology to optimize personalized drug delivery systems (DDS) for patients, establishing new treatment strategies minimizing side effects. Additionally, develop international clinical trial networks and propose updates to testing design models addressing client shortages.
Example of Quantum Technology	1. Quantum Machine Learning Utilize machine learning through quantum computers to analyze genetic characteristics related to diseases without treatment methods, such as rare diseases and pediatric cancers. This is expected to strengthen the foundational technology for the realization of personalized medicine. 2. Simulation Using Quantum Computers Perform simulations of interactions at the molecular level using quantum computers. This is expected to rapidly identify new candidate target therapies. Additionally, by leveraging optimization methods with quantum computers, design systems to efficiently deliver drugs to target sites, potentially minimizing side effects.
Expected Outcomes	This project anticipates expanding treatment options, promoting the development of effective treatments. Implementing side effect reduction can enhance patients' QOL and social labor environments, advancing new treatment developments for rare diseases and pediatric-adult domains, becoming priority challenges for Japan's regions and healthcare facilities.
Keywords	Rare diseases, individualized medical foundation, quantum machine learning, quantum optimization

Intellectual Activity Support Using Quantum Computers

Background	In nowadays society, congenital intellectual disabilities, dementia, autism, and various disabilities affecting intellectual activities are increasing. Fundamental treatments and support systems for these disabilities remain limited, increasing the burden on patients, families, and society as a whole. Moreover, the formation of an inclusive society supporting elderly individuals and children with intellectual disabilities is sought. Therefore, leveraging advanced technologies like Brain Machine Interface (BMI), quantum computers, and AI to deepen the understanding of brain functions and behaviors in individuals with intellectual disabilities is crucial.
Content	1. Use BMI and quantum technology to measure brain activity and blood flow data, create a synapse model of the brain, and assess effects on drug treatments contributing to identifying causes of disabilities. This deepens the understanding of brain functions. Subsequently, utilize AI and quantum computers to analyze how external stimuli impact symptoms, developing new medications, introducing treatments, educational methods for capability development, and patient care clinics based on these insights for intellectual disabilities and dementia. 2. Create a model predicting social activities for overall brain activity and intellectual activities. For instance, predict behaviors of dementia patients and individuals with intellectual disabilities, and identify behavioral factors. Aim to enhance prediction accuracy by analyzing advertisement target demographics or products using quantum computers. Once behavioral factors are identified, alerts can be issued in advance and appropriate support methods examined.
Example of Quantum Technology	1. Brain Model Creation and Simulation Using Quantum Computers Conduct real-time analysis utilizing AI technology, model complex interactions within the brain like synapses and neurons, simulate their activity, and facilitate understanding. This may bring innovations supporting intellectual activities. 2. Quantum Machine Learning Analyze biometric and environmental data with quantum machine learning to more accurately grasp behavioral patterns and risk factors for individuals with intellectual disabilities, potentially contributing to examining appropriate support methods. 3. Quantum Optimization Based on predicted behavior, use quantum optimization to optimally introduce living environments and intervention methods. This may propose concrete indicators for minimizing risks and improving the QOL of individuals with intellectual disabilities.
Expected Outcomes	This initiative enables precise measurement and simulation of the brain, deepens brain function understanding, and advances effective support and care for individuals with intellectual disabilities, dementia patients, and children with autism. Additionally, through data analysis of advertisement target demographics and product target demographics, it aims to contribute to the formation of an inclusive society.
Keywords	BMI (Brain Machine Interface), individuals with intellectual disabilities, dementia patients, autism brain model, social consensus, quantum optimization, quantum machine learning

Development of Ultra-High-Speed Biological Information Analysis Methods

Background	The genetic analysis market is growing at an annual rate of approximately 17%, and it is predicted to reach approximately 2.2 trillion yen by 2024 and 7 trillion yen by 2032. In Japan, genetic testing, such as for cancer diagnosis, is covered by insurance. However, many tests are conducted overseas, posing concerns over capital outflow and the leakage of important biological information. The absence of strong sequencing development companies domestically raises concerns over delays in stable provision of advanced medical care and competitive drug development. Advancements in sequencing technology are shortening sequencing costs and time, yet the computing and analysis time, cost, and accuracy of the vast data arising from sequencing remain a bottleneck. Although research on proteins generated by genetic sequence analysis is progressing, the mechanisms connecting genetic sequences to the expression of genes via RNA and catalysts remain unsolved. Unraveling these mechanisms is expected to progress innovation utilization and eventually contribute to realizing a low-carbon society.
Content	This issue aims to leverage quantum computers to computationally utilize antisense technology, developing algorithms and applications to address current bottleneck areas. Additionally, alongside the above, solutions are expected to be proposed for the elucidation of RNA and catalytic reaction mechanisms using quantum computers, as well as the development of mechanism analysis methods. ・Solving challenges related to genetic information analysis using quantum computers ・Elucidating RNA functions and enzyme catalytic reaction mechanisms using quantum computers
Example of Quantum Technology	1. Data Analysis Using Quantum Algorithms Apply methods such as Grover's search algorithms and quantum machine learning to genetic information analysis, quickly identifying essential molecular data, expected to streamline analysis processes.
Background	・If genetic information processing technology using quantum computers is established, it is expected to enhance competitiveness in the DNA sequencer market and strengthen medical provision and drug development enterprises within Japan. Achieving improved precision in the identification of three-base molecules and reduced analysis time is anticipated to streamline analysis efficiency and enhance accuracy. ・Unraveling RNA catalytic mechanisms of DNA and proteins advances innovation utilization and contributes to realizing a low-carbon society.
Keywords	Gene analysis, DNA sequencer, quantum machine learning

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Development of Quantum Computing Algorithms for Designing Treatment Protocols for Multi-Drug-Resistant Infections

Background	Multi-drug-resistant organisms (MDROs) have become a global health threat due to the extensive use of antibiotics. In Japan and worldwide, the number of deaths from infections is increasing, necessitating new treatment strategies.
Content	To advance bacterial infection treatment development, control bacterial groups to deprive pathogens of the nutrients they require, thereby inhibiting MDRO proliferation. Specifically, for a pathogen's activity, it is expected to find combinations of bacteria that cut off nutrient supply to pathogens that can use each nutrient. Develop quantum optimization methods to solve combination optimization defining these bacterial combinations.
Example of Quantum Technology	1. Quantum Optimization Apply quantum optimization to the problem of selecting optimal combinations from numerous bacterial data structures, potentially allowing efficient exploration of optimal solutions. 2. Simulation Using Quantum Computers Model interactions among resident bacteria and their effects on pathogens and simulate using quantum computers. This is expected to predict treatment effects and inform optimal treatment strategies.
Expected Outcomes	This project accelerates bacterial infection treatment development, offering new treatment strategies against MDRO infections. Anticipating suppression of MDRO propagation in hospitals, reducing patient infection risks, contributing to treatment design and manufacturing cost reduction in the pharmaceutical industry. Additionally, application to agriculture by utilizing simulation methods for bacterial group control, potentially identifying combinations of easily cultivated crops and plants.
Keywords	Pharmaceutical industry, antibiotics, multi-drug-resistant organisms (MDRO), bacterial infection treatment, infection risk reduction, quantum optimization, quantum simulation

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Development of Privacy-Protective Medical Data Integration Methods Using Quantum Federated Learning

Background	In the research and development of personalized medicine, the application of machine learning is advancing; however, strict privacy regulations around patient medical information centralize data, hindering data integration for collaborative research. Federated learning is being noted as a method for model training while keeping data distributed, but challenges arise in addressing data heterogeneity, processing efficiency of small-scale data, and communication costs. Quantum federated learning has the potential to resolve these issues, enhancing computational efficiency and fortifying privacy protection.
Content	This project aims to develop decentralized data integration technology using quantum federated learning. Specifically, it involves achieving computational speeds surpassing traditional algorithms to efficiently handle small-scale data for rare diseases and personalized multi-factor diseases and utilizing quantum computing algorithms to adaptively integrate data from different hospitals and regions. Additionally, the project aims to strengthen security during data transmission and computation processes by employing encryption technologies using quantum technology.
Example of Quantum Technology	1. Quantum Federated Learning Applying quantum computers to federated learning is expected to enhance efficiency and security when sending, integrating, and computing small-scale datasets for rare diseases and personalized multi-factor diseases, as well as numerous datasets from different hospitals and regions.
Background	If decentralized data integration technology using quantum federated learning is validated through this project, it will contribute to international rare disease research and personalized medicine research. Specifically, if computational efficiency and accuracy are enhanced and communication costs reduced, data integration will be feasible while protecting privacy. Furthermore, by leveraging this technology, Japan may exhibit international leadership.
Keywords	Personalized medicine, rare diseases, quantum diseases, privacy protection, quantum federated learning

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Construction of Optimal Visiting Nursing System

Background	Japan has entered a super-aging society, resulting in a surge in demand for home nursing. However, the increased travel time of nursing staff, the difficulty in emergency response, and imbalances in resource distribution between regions are challenges. Moreover, decision-making using patient and mobility data has not progressed, making the establishment of efficient care systems essential. An inclusive society that supports the elderly and patients left behind by society is anticipated.
Content	This project aims to optimize home visit routes and schedules using quantum computers, as well as advance patient data analysis and nursing demand forecasting to achieve an efficient and sustainable home nursing system. This will aim to reduce the travel time of nursing staff and expedite emergency responses. Additionally, it seeks to optimize resource distribution between regions and improve nursing service quality.
Example of Quantum Technology	1. Analysis of Patient Data and Demand Forecasting Using Quantum Algorithms Quantum machine learning technology can be utilized for the analysis of patient data and demand forecasting. This could enable personalized care plans based on individual patient conditions and regional characteristics. 2. Enhancing Data Security with Quantum Technology By employing quantum algorithms to enhance encryption, it could be possible to improve the security of data transmission and processing. Expected outcomes include leveraging patient and mobility data, whose privacy and security are ensured, for the efficiency of care systems.
Expected Outcomes	Through this project, reducing nursing staff travel times significantly boosts operational efficiency and expedites emergency response. Additionally, by combining with telemedicine and applying to home care, nursing and care resources can be utilized efficiently, achieving cost reduction. Further expected advantages include improved patient and caregiver satisfaction, enhanced care quality, and increased nursing and care service quality in communities, contributing to forming an inclusive society that supports elderly individuals left behind by society.
Keywords	Home nursing, nursing staff resource allocation, nursing demand forecasting, improvement of nursing service quality, social inclusion, quantum machine learning

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Development of Next-Generation Menu Planning System Using Quantum Technology

Background	For nutritional treatment and prevention aimed at extending healthy life spans, appropriate nutritional intake is necessary, and the realization of this is beyond individual efforts, making the establishment of environments enabling appropriate nutritional intake as a society crucial. In Japan, there are over 55,000 food service facilities, and among them, more than 50,000 specific facilities are subject to nutritional management standards (according to the Ministry of Health, Labour and Welfare - Health Administration Report for Fiscal Year 2023). In these facilities, qualitative improvements in large-scale meal operations contributing to individualized nutrition management and well-being enhancement are demanded, as nutritional intake's therapeutic or health effects cannot be maintained. Improvements in average pricing, quality stability, meal satisfaction, and optimal use of well-being systems for users are needed.
Content	The project's realization should consider multiple factors: 1) Nutritional elements related to menu creation, such as user health condition, preferences, economic burden (affordability), and 2) Factors for food service facilities to realize menus (facility equipment and manpower), and 3) Elements concerning ingredient sourcing inside and outside meal contexts, and 4) Factors related to reducing greenhouse gas emissions and environmental burdens through food service systems. This challenge will develop mechanisms for optimizing menu design, extracting preference patterns, and realizing efficient food service operations.
Example of Quantum Technology	1. Extraction of Preference Patterns Using Quantum Computers By analyzing past preference data using machine learning and optimization methods with quantum computers, extracting individual user preference patterns may become possible. This can potentially provide personalized nutritional management and improve user satisfaction. 2. Efficiency of Food Service Operations Using Quantum Computers By analyzing operational data from food service facilities using quantum computers, constructing models for predicting leftover rates, for example, may become feasible, utilizing quantum optimization to procure resources and manage risks.量子コンピュータによる嗜好性パターンの抽出
Expected Outcomes	Nutritional management through food services presents the technology and systems by Japan reflecting their historical and large-scale approach. School meal systems are being constructed nationwide as models for nutritional growth, learning indicators, aiming to reduce environmental burdens while contributing to the improvement of global health and well-being. Adapting and commercializing these systems according to school circumstances as businesses also holds promising prospects.
Keywords	Personalized nutrition management, operational management systems, extraction of preference patterns, leftover rate prediction models, quantum machine learning

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Machine Generation of Interactive Educational Materials and Learning Policies (Including Test Questions for Ability Measurement) Using Quantum Computers

Background	In recent years, there has been a shortage of teachers capable of providing excellent learning guidance tailored to individual abilities in educational settings worldwide. As a result of this problem, the following challenges have arisen: ・Education systems need to be updated in line with the times. ・Providing materials and problems with difficulties tailored to personal needs requires advanced personal skills, with limited personnel and significant costs. ・Traditional human-based educational materials and learning policies are patterned and repeatedly predicted through past exam questions, making it challenging to accurately assess academic ability. Consequently, the accuracy of screening based on deviation scores decreases, leading to significant measurement errors in genuine academic ability and understanding, and risking the loss of opportunities to nurture talented individuals.
Content	To address this problem, the development of AI that automatically generates materials and problems optimized for learning purposes and goals, and suggests learning policies, will be advanced. By utilizing quantum computers, achieve conditions appropriate for difficult problems that are challenging for current generative AI systems.
Example of Quantum Technology	1. Quantum Machine Learning It is expected to generate customized materials and problems tailored to each student's learning history and comprehension level. Using quantum machine learning may uncover learning patterns that conventional methods might overlook. 2. Quantum Optimization By using quantum optimization to automatically determine combinations of problems and task difficulty, it could precisely enhance the creation of materials and learning policies. This is expected to lead to reducing teacher burdens and cutting back on efforts and time.
Expected Outcomes	The introduction of AI systems utilizing next-generation quantum computers will lead to optimized learning guidance for individuals in educational settings, enabling accurate evaluation of learning and comprehension. This will promote the emergence of excellent talent and is expected to improve the quality and efficiency of education. Teachers will have increased capacity to focus from creation to executing the educational process, resulting in improved overall educational quality.
Keywords	Education, update of educational content, personalized material generation, quantum machine learning, quantum optimization

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Understanding Personality Using Quantum Computers and AI

Background	In modern society, the datafication and secure management and sharing of memory hold the potential to generate new value across diverse fields such as education, medical and psychological care, and entertainment. Particularly, memory data utilization is anticipated to support declines in cognitive function for forming inclusive societies, advance experiential learning content, and create virtual experiences. However, addressing ethical challenges such as privacy protection and prevention of memory alteration is also necessary.
Content	This project will integrate quantum computers and AI technology to develop new methods for securely managing and sharing digitalized personal memories. Specifically, encrypt memory data based on appropriate importance and use quantum technology-enhanced data security to share securely. Additionally, implement mechanisms allowing users to control the public scope of memory data and equip functions for retaining change histories and restoring original memories.
Example of Quantum Technology	1. Understanding Humans Using Quantum Computers If human memory data can be encoded on quantum computers, quantum machine learning may significantly contribute to advanced understanding of humans. 2. Data Protection with Quantum Technology Using quantum algorithms to enhance confidentiality can prevent data theft and tampering along communication paths, enabling the creation of secure information-sharing platforms.
Expected Outcomes	This project is expected to establish new utilization methods for memory data, strengthen support in the medical field, and contribute to forming inclusive societies involving cognitive patients. In education, experiential learning will be promoted, enhancing content and spreading more effective educational systems. Memory-sharing foundation for experiential facilities will advance knowledge-sharing across society, fostering harmony between technology and human societies. Consequently, the societal acceptance of secure memory data usage is anticipated, expanding possibilities for new value creation.
Keywords	Datafication of memory, experiential learning, treatment of memory disorders, social inclusion, confidentiality algorithms

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Life Simulation and Well-Being Improvement Using Quantum Technology

Background	An individual's quality of life (QoL) is influenced by various factors such as asset level and health status. To evaluate it appropriately, multi-attribute utility functions are utilized, providing a framework for integrative evaluation of different factors. Utilizing this framework enables rational decision-making support for expenditures necessary for health maintenance, choices of health insurance, investments in disease prevention measures, and more.
Content	This project will formulate multi-attribute utility functions corresponding to individual QoL and construct expected effect functions considering age, income, health status, etc. Based on this information, develop applications that demonstrate action plans to improve user's QoL, such as optimal savings plans, consumption strategies, disease prevention measures.
Example of Quantum Technology	1. Quantum Machine Learning Utilize machine learning on quantum computers to analyze diverse data such as age, income, health status. This is expected to contribute to deriving complex correlations and multi-attribute utility functions corresponding to individual QoL. 2. Quantum Optimization Quantum optimization is expected to present action plans to improve QoL from complex choices like savings plans, consumption strategies, disease prevention. 3. Risk Evaluation Using Quantum Computers Simulate future risks and uncertainties, performing risk evaluation based on expected utility, potentially supporting decision-making and strategy planning.
Expected Outcomes	The introduction of this application is expected to provide individuals with concrete guidance to improve their quality of life. Additionally, it may be utilized as simulations supporting policy formulation. This anticipates increased rational decision-making and improvements in QoL. Furthermore, supporting investments in appropriate health insurance and disease prevention measures to reduce health risks and contribute to controlling medical expenses is expected.
Keywords	Evaluation of QoL, multi-attribute utility functions, optimization of action plans, quantum machine learning, quantum optimization

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Development of Crystal Structure Prediction System for Organic Molecules using Simulation for Optimizing Atomic Spatial Configurations

Background	In pharmaceutical companies, it is important to crystallize drug molecules in order to control dissolution rates and eliminate impurities. However, organic molecules often exhibit multiple crystal polymorphs with different stereochemistry and spatial arrangements, which affect solubility. Therefore, selecting a stable crystal form is crucial for tablet manufacturing. The phenomenon known as "late-appearing polymorph," in which the most stable crystal form emerges after a metastable one has been obtained, can lead to reduced drug efficacy and difficulties in stable supply, potentially disadvantaging patients. In the research and development of functional materials, even slight modifications to molecular structures can significantly impact crystal structures and their properties. As a result, it is needed to reduce the computational cost required for crystal structure prediction.
Content	This issue aims to develop a system using quantum computing techniques, like quantum annealing, to predict the crystal structures of organic molecules. Through quantum optimization, the optimal combination of variables that determine the spatial configuration of molecules can be efficiently explored, significantly reducing computational cost compared to conventional classical computing methods.
Example of Quantum Technology	1. Quantum Optimization Since combinatorial optimization problems can be solved efficiently, this approach has the potential to be applied to the optimization of molecular spatial configurations. As a result, it is expected to significantly reduce the computational cost of crystal structure prediction and enable high-precision forecasting. 2. Simulation Using Quantum Computers Using quantum computer simulations, it is expected to analyze energy differences between crystal polymorphs more precisely, thereby improving the accuracy of predicting the most stable structures. A detailed understanding of how crystal structures are actually formed is expected to contribute to the discovery and prediction of new crystal forms. 3. Quantum Machine Learning By using quantum machine learning algorithms, data-driven models can be constructed to efficiently learn patterns and trends for predicting crystal polymorphs from vast molecular datasets. This is expected to accelerate the exploration of unknown crystal structures.
Expected Outcomes	Developing this system is expected to ensure a consistent supply of pharmaceuticals in the industry, thereby safeguarding patient safety. Furthermore, in the research and development of functional materials, it will enhance the success rate of molecular design and contribute to improved competitive advantage. By leveraging the optimization capabilities of quantum computing to reduce computational cost, this approach enables more efficient crystal structure prediction and expands the range of molecules that can be reliably predicted, bringing innovation to molecular design.
Keywords	Quantum optimization, simulation using quantum computers, crystal structure prediction, drug development, drug discovery

Cool Japan

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Consideration of Innovative Game Systems Using Quantum Computers

Background	While the game industry is exploring new experiences through advancements in AI and cloud technology, computational resource constraints are limiting creativity.
Content	This issue aims to build unprecedented game systems using quantum computers, leveraging principles of quantum entanglement and superposition. Record player choices as quantum states and dynamically change game development based on results to build a fair game environment without cheat-like operations. Additionally, visualize quantum characteristics through design, aiming to provide educational elements of quantum mechanics while enjoying games.
Example of Quantum Technology	1. Encoding and Manipulation of Quantum States By encoding player choices into quantum states, it becomes possible to further diversify decision-making within games. Leveraging principles of quantum entanglement and superposition may build dynamic systems where player choices influence game endings. This is expected to offer varied experiences for each player, enhancing replay-ability. 2. Cheat Prevention Using Quantum Technology Utilizing quantum technology can potentially create game environments impervious to third-party manipulations (preventing cheat-like operations)
Expected Outcomes	• Establishing new game systems based on quantum computers • Building game environments fostering player attraction and competition • Realization of innovative game design through reduced computational costs and development time Through this endeavor, evolution in Japanese gaming culture and enhancement of "Cool Japan" brand value are anticipated.
Keywords	Gaming Industry, Cheat Prevention, Quantum Entanglement, Quantum Superposition, Quantum Mechanics Education

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Game Balance Optimization Using Quantum Computers

Background	In recent years, the online gaming market has rapidly expanded. However, cheating undermines fair gameplay environments, diminishing the enjoyment of games. Cheating includes automated operation tools, memory tampering tools, and improper game clients and server attacks, leading to the collapse of game systems and deterioration of player communities, causing economic harm to operators. Addressing cheating issues is a major challenge for the gaming industry, requiring reliable countermeasure technologies and multifaceted efforts.
Content	This issue aims to resolve online game cheating problems using innovative technologies with quantum computers. Specifically, targeting the following technical areas: 1.Acceleration of cheat detection: Utilize quantum computers to validate algorithms that detect rogue players and abnormal behavior. 2.Enhancing Communication Security: Utilize encryption technologies employing quantum technology to prevent misconduct detection and eavesdropping. 3. Anomaly Detection in Player Behavior: Utilize quantum machine learning to analyze player action data in real-time, predicting and inhibiting misconduct in advance.
Example of Quantum Technology	1. Cheat Detection Using Quantum Algorithms Using quantum algorithms is expected to detect anomalies at specific rates faster than classical computers. For example, quantum algorithms are anticipated to discover data spaces for algorithms analyzing massive game log data to rapidly detect unusual patterns. 2. Enhancing Data Security Encryption technology using quantum computers has the potential to significantly enhance the security of communications. By employing encryption technologies utilizing quantum technology, it is expected to substantially reduce the risks of eavesdropping and tampering, thereby strengthening the security of in-game communications. 3. Quantum Machine Learning Using quantum machine learning to extend traditional machine learning technologies, enabling faster learning and prediction. Utilizing quantum machine learning is expected to analyze player action data in real-time, allowing the detection of abnormal behaviors.
Expected Outcomes	• Improve cheat detection speed • Enhance communication security and establish standard models • Identify abnormal behavior • Realization of innovative game design through reduced computational costs and development time This effort is anticipated to enhance fair play environments in online games and improve player experiences.
Keywords	Online games, cheating activities, data tampering/eavesdropping, anomaly detection in players, enhanced player experience, quantum machine learning

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Quantum-Based Cross-Media Content Optimization Engine

Background	The conversion process among different media platforms such as manga, anime, and games currently relies heavily on manual work, requiring substantial costs and time. Additionally, cultural backgrounds and visual representations differ between countries, posing challenges to bridging these gaps. Consequently, it is becoming increasingly difficult to develop Japan's content as a future attraction globally.
Content	For this issue, we propose the development of a cross-media optimization engine using quantum computers. This engine will possess the following capabilities: 1.Optimize the cross-media conversion process: Model character settings and storyline structure hierarchically, drastically reducing manual work time. 2.Adapt content individually: Optimize the color and design of characters for each market, and streamline storyline settings to enhance acceptance in international markets.
Example of Quantum Technology	1. Quantum Optimization Quantum optimization is suited to solving combination optimization problems, applicable to modeling diverse character settings and storyline structures in the cross-media conversion process. Utilizing quantum optimization may significantly reduce manual work time. This is expected to enable the conversion to new media platforms quickly, facilitating global content acceptance. 2. Quantum Machine Learning Quantum machine learning, handling large datasets, recognizes patterns from different cultural backgrounds, allowing learning from data like character colors and designs, contributing to storyline optimization. This autonomous processing enhances content acceptance in international markets.
Expected Outcomes	• Realization of the Cool Japan Strategy: Emphasize the strengths of Japan's creative industries and provide cutting-edge content production methods using quantum computers. • Economic Impact: Promote industry-wide revitalization by reducing production costs and providing systems accessible to emerging creators and small and medium-sized enterprises. This technology is expected to be a significant aid for small-scale creators and SMEs in achieving global expansion, enhancing the international competitiveness of Japanese cultural content.
Keywords	Content market, cross-media conversion process, international market adaptation, quantum optimization, quantum machine learning

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Quantum Diffusion Model for Manga and Animation Production

Background	Diffusion models, forming the foundation of current image-generating AI, can generate high-quality images, but face significant challenges due to their generation time. In comic and animation production, resolving this issue is essential for realizing AI that assists creators.
Content	Addressing this issue by undertaking the following efforts: 1.Verification of Quantum Computability for Current Diffusion Models: Verify whether current diffusion models can implement quantum computation. 2.Development of Efficiency Enhancement Methods Using Quantum Algorithms: Develop new efficiency enhancement methods with quantum algorithms aimed at shortening generation time. 3.Prototype Design Using Noise Tolerance and Error Correction Technology: Test whether they operate on noise-prone quantum computers.
Example of Quantum Technology	1. Investigation and Evaluation of Quantum Applicability of Diffusion Models: To investigate the quantum applicability of diffusion models, first consider the approach of quantum computers. For example, evaluate whether the overall generation process can be optimized using the expressive power of qubits, and also assess whether specific quantum algorithms are suitable for computing probability distributions or sampling within diffusion models. 2. Development of Efficiency Enhancement Methods Using Quantum Algorithms: Using quantum algorithms allows for more efficient handling of large-scale data, accelerating areas that traditionally take time. Explore specifically how quantum algorithms can be utilized within the generation process. 3. Construction and Trial Implementation of Prototype Models for Quantum Computers: Build prototype models based on newly developed efficiency enhancement methods, conducting trials on actual quantum computers or simulators. By testing noise tolerance and error correction technology within such prototype designs, exploring the possibility of achieving operational improvements compared to current conditions.
Expected Outcomes	• Significant reduction in generation time, providing creators with environments conducive to efficient work. • Strengthen the international competitiveness of Japanese manga and anime production through advancements in AI technology • Promote the revitalization of the entire creative industry by establishing new production methods Through this initiative, creators will be able to utilize AI more effectively, leading to improvements in industry-wide productivity and the development of new creativity.
Keywords	Image-generating AI, creative industry, quantum machine learning, quantum diffusion models

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Interactive Theme Park and Tourist Site Management System Using Quantum AI

Background	In the operation of theme parks and tourist destinations, improving visitor satisfaction and efficient management are crucial. However, the current situation presents the following challenges: 1.Congestion and long wait times burden visitors. 2.Effects of overtourism deteriorate local and natural environments. 3.Diverse needs are difficult to meet, and customized optimization according to visitor age, gender, and cultural habits is challenging. 4.Optimizing staff allocation and inventory management is challenging, resulting in inefficiencies due to resource surpluses or shortages.
Content	Addressing these issues by integrating quantum computers and AI technology to achieve the following: 1.Optimizing visitor movement: Use quantum algorithms to analyze cost-saving data, offering optimal routes that avoid congestion. 2.Provide personalized attractions and services by analyzing preferred trends for visitors to optimize individual experiences. 3.Optimize resource allocation: Streamline domestic resources (electricity, inventory, staff allocation) using quantum computers.
Example of Quantum Technology	1. Quantum Optimization Quantum algorithms may be used to compute optimal routes that avoid congestion. This rapidly evaluates combinations of different routes, providing ideal travel paths for visitors and tourists. This could efficiently reduce wait times and promote environmental protection locally. Additionally, quantum technology might be applied to theme park operations for energy, inventory, and staff allocation resources. Quantum optimization minimizes resource surplus and shortages, appropriately allocating resources in time and place, enhancing operational efficiency. 2. Quantum Machine Learning Utilize quantum machine learning to analyze visitor behavior data. With quantum computers, it is expected to provide personalized attractions and services for each visitor. This leads to offering individual experiences based on culture, age, and gender, enhancing satisfaction.
Expected Outcomes	• Enhanced visitor satisfaction and reduced operational costs. • Addressing overtourism, protecting tourist livelihoods. • Contribute to the promotion of Cool Japan by strengthening brand power of theme parks.
Keywords	Theme parks & tourist destinations, overtourism, optimizing tourist experiences, optimizing theme park operations, quantum machine learning, quantum optimization

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Anime World Experience with Five-Sense Simulation Wearables

Background	Japanese anime and manga boast great popularity both domestically and internationally, but current AR/VR technologies mainly focus on visual and auditory sensations and have yet to provide a complete immersive experience. Particularly, there are technical challenges in utilizing senses such as smell and touch.
Content	Develop technologies to provide experiences that blend anime worlds with reality using all five senses in cities and tourist spots. Utilize quantum computers to integrate and process various sensory data, realizing simulations of integrated sensations. Additionally, offer new tourism value by combining technologies for generating individually optimized experiences.
Example of Quantum Technology	1. Simulation Using Quantum Computers Use quantum algorithms to potentially realize sensory simulations. This is expected to efficiently integrate different sensory data such as visual, auditory, olfactory, and tactile to provide highly immersive experiences. 2. Quantum Machine Learning Analyze user preferences and past behavior data using quantum machine learning technology to potentially generate personalized experiences. This aims to provide tailored tourist experiences, improving satisfaction.
Expected Outcomes	• Realizing wearable devices encompassing the five senses (visual, auditory, olfactory, tactile, taste), reconstructing cities and tourist spots as "anime stages," is expected to contribute to town revitalization and regional development. • Generate individualized experiences based on individual preferences, creating new tourism and commercial value. • Applications in the wellness and healthcare fields are also anticipated. This endeavor is expected to create new experiential and tourism value, further broadening the appeal of Japanese anime culture.
Keywords	VR/AR, sensory simulation, optimization of tourism experiences, quantum machine learning, quantum optimization

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Development of "Touchable Anime" Experience Using Dynamic Tactile Reproduction Technology

Background	Anime and manga are representative contents of Japanese culture, playing important roles in tourism and entertainment industries. However, current entertainment technologies are limited to visual and auditory experiences, leaving the haptic sense as an unexplored field. This limitation hinders the enhancement of immersion.
Content	Utilize quantum computers to realize haptic feedback, providing realistic haptic experiences based on the world of anime and manga, creating new value in tourist sites and commercial facilities.
Example of Quantum Technology	1. Quantum Optimization Using quantum optimization for haptic feedback may efficiently solve complex optimization problems related to haptic feedback generation. This potentially allows for optimization of device design and system adjustments to generate realistic and intuitive haptic experiences. 2. Data Integration Using Quantum Computers To integrate visual and auditory data with haptic data from anime and manga, quantum computers might efficiently process data from different senses. This enables the potential realization of immersive experiences integrated with all five senses. 3. Quantum Machine Learning Analyze haptic feedback data concerning individual user preferences and focus points, potentially generating optimized haptic feedback for each individual. Utilizing quantum machine learning adjusts experiences based on user reactions, offering more personalized immersive experiences.
Expected Outcomes	• Establishment of optimization technologies for haptic feedback generation using quantum computers. • Development of wearable devices promoting quantum data integration to enhance haptic experience quality. • Creation of immersive entertainment displays in tourist sites and commercial facilities. Through integrating all five senses for immersive experiences, this effort enhances the use of Japan's cultural anime and manga, providing new experiential value in tourism and commercial sites.
Keywords	Entertainment Industry, Haptic Feedback, Quantum Optimization, Quantum Machine Learning

Realization of Quantum-Driven Cultural Experience Through Fortune-Telling Using Quantum Computers (Finding "Wabi-Sabi" and "Mono no Aware" and "Cool Japan" in NISQ)

Background	Traditional Japanese culture deeply roots in elements like "fortune-telling" and "omikuji" (Japanese fortune slips) that find meaning through natural randomness. On the other hand, quantum computers, due to their probabilistic characteristics, hold new possibilities that diverge from conventional computing. Combining these elements is expected to create new cultural value and enhance interest in quantum computing. Also, through fortune-telling, a space for nurturing quantum thinking, which might be challenging for beginners, is provided.
Content	Utilize probabilistic quantum computing to develop "quantum fortune-telling" by blending traditional Japanese "fortune-telling" and "omikuji." This initiative includes the following elements: 1. Display Results Based on Quantum Bit State and Measurement: Interpret specific probabilities as "oracle" messages. 2. Incorporate Elements of Japanese Culture through Character Interaction Devices: Provide entertainment apparatus enabling the experience of quantum computing. 3. Integrate Educational Elements to Enjoyably Learn Quantum Technology Basics, Encouraging Next-Generation Interest.
Example of Quantum Technology	1. Use Quantum Bit States for Fortune-Telling Results: Quantum bit states use superposition, where fortune-telling results are probabilistically determined until measured. Leveraging this characteristic might allow using quantum bit states to produce veritable fortune-telling results. This allows potentially generating fortune outcomes like "Great Blessing" or "Misfortune," providing everyday enjoyment through randomly generated experiences. 2. Provide Apparatus Intuitively Demonstrating Quantum Computing Processes: Prepare user interfaces incorporating daily cultural elements, enabling users to experience quantum computing processes. For example, visualize quantum bit states with characters explaining their changes, making intuitive understanding of quantum computer operations in entertainment apparatus accessible. 3. Inclusion of Educational Elements to Learn Quantum Foundations: Integrate foundational quantum mechanics elements into the fortune-telling experience, potentially providing a venue for enjoyable learning. For instance, learning how fortune results are generated using quantum bits, creation of opportunities for quantum computer education is expected.
Expected Outcomes	• Provide new cultural experiences using quantum technology • Promote "Cool Japan" through the fusion of traditional Japanese culture and cutting-edge technology • Increasing awareness of quantum computing and providing educational value to the next generation Through this initiative, aim to enhance dissemination of awareness of quantum computing and Japanese culture while pursuing the creation of new markets.
Keywords	Quantum fortune-telling, quantum bits, quantum mechanics education

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Provision of New Rendering Environment

Background	Rendering is a process that visually converts digital data, essential in fields like 3D animation, game development, filmmaking, and even architecture and product design. However, rendering requires substantial computational resources, particularly GPUs (graphics processing units) playing a central role in handling advanced graphics processing. Recently, GPU prices have soared, making equipment investment and operational costs a significant burden for production sites. Smaller creative studios especially struggle to secure high-performance rendering environments. The traditional GPU-centric setup limits the scalability and efficiency of available resources, inadequately addressing increasingly complex content creation needs.
Content	To solve this issue, it is necessary to transition to a physical infrastructure network and construct new rendering environments not reliant on traditional GPUs. The specific objectives are as follows: 1. Realization of GPU alternative infrastructure: Design and develop a computing system that delivers performance equivalent to current GPUs. This system must hold high compatibility with rendering engines and smoothly integrate into existing production environments.。 2. Improvement of usability: Provide a simple interface for interacting with standard rendering engines, creating an environment where creators can use it without needing specialized knowledge.
Example of Quantum Technology	1. Quantum Optimization Quantum computers are expected to find solutions for specific computational problems faster than classical computers. Particularly in ray tracing processes crucial to rendering and simulation optimization, leveraging quantum optimization could realize more efficient rendering processes. 2. Construction of Quantum Computing Networks Utilizing quantum computers as infrastructure may allow constructing new rendering environments not reliant on traditional GPU-centric systems.
Expected Outcomes	• Provide high-performance computing infrastructure accessible to small-scale creators • Improvement of Production Efficiency in the Creative Industry • Revitalize the entire industry through the proliferation of rendering environments This endeavor realizes immersive experiences integrating all five senses, further expanding the appeal of Japanese anime culture, providing new experiential value in tourism and commercial facilities.
Keywords	Creative industry, rendering environments, quantum optimization

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Revival of Lost Japanese Cities Using Quantum Computers

Background	Japanese cities maintain cultural landscapes and streetscapes through the efforts of many, but urban development may threaten these landscapes and streetscapes. To pass on wonderful cultural heritage to future generations, mindful activities towards cultural asset evaluation and streetscapes are vital. Additionally, in the tourism industry, leveraging lost historical landscapes for new value offerings is sought.
Content	Aim to digitally restore lost cities using quantum computers, facilitating cultural heritage transmission and tourism industry development. The specific initiatives are as follows: 1. Reproduce urban structures in real-time using quantum computers based on historical materials. 2. Build interactive urban experiences within virtual reality (VR) or metaverse spaces. 3. Create digital archives to contribute to future research and tourism project development.
Example of Quantum Technology	1. Urban Reconstruction via Quantum Simulation: Quantum computers excel at simulating complex systems. Using quantum computer simulations based on historical documents and geographical data may efficiently generate models for reconstructing lost city structures. This could accelerate urban reconstructions requiring management of numerous combinations and parameters. 2. Quantum Optimization: Recreating city structures requires analyzing extensive data and determining optimal placements or designs. Quantum optimization suits combinatorial optimization challenges, aiding in deriving information for rebuilding cities from substantial historical data. Utilizing this technology, the potential to construct more coherent urban models exists. 3. Quantum Machine Learning: Quantum machine learning might be applicable when organizing historical documents and city data as digital archives. Efficiently classifying large datasets, effectively correlating high-relevance information, and potentially offering urban experiences as digital content leans on this possibility.
Expected Outcomes	• Protect and transmit cultural heritage via digital restoration of lost cultural landscapes. • Utilize for education and tourism industries, and create new tourist destinations. • Provide historical landscapes and new educational value as digital content. This initiative digitally recreates past cultural landscapes, offering new value to modern education and cultural promotion.
Keywords	Cultural heritage transmission, tourism industry, urban structure reconstruction, VR/metaverse, quantum computing, quantum machine learning.

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Development of Matching System Using Quantum Characteristics in Nurturing Games

Background	The issue of pet abandonment, where pets are neglected and, consequently, abandoned or taken to animal shelters, is a social problem. Therefore, by applying quantum randomness to virtual pet behavior, creating a game that scores pet care and proposes pet types fitting users' lifestyles, the aim is to address pet abandonment through constructing nurturing and matchmaking games. This game system eliminates traditional game constraints such as "acting based on deterministic programming allows players to easily predict behaviors," providing new gameplay experiences. Additionally, offering matchmaking through quantum technology anticipates the spread of quantum technology.
Content	Leverage quantum computer characteristics (superposition, probabilistic, randomness) to develop next-generation virtual nurturing game and matchmaking systems. This initiative includes the following elements: 1. Character Development Game Build systems that reflect quantum computation probabilistic characteristics in character actions and growth, based on user choices and environment. (Character examples: virtual pets, anime characters, local mascots, idols, sports teams, etc.) 2. Matching System Utilize quantum computers to approach matchmaking issues using player preferences, data, and character parameters as variables.
Example of Quantum Technology	1. Random Nurturing and Scenario Branching Using Quantum Technology By using randomness in quantum technology, it becomes possible to randomly determine character actions and events, potentially achieving freshness unattainable through deterministic programs. 2. Quantum Optimization Set data like player preferences and character parameters as energy functions for scoring based on multiple variables to minimize or maximize, aiming to find optimal solutions. For example, anticipate realizing matchmaking systems by quantifying information about local mascots or sports teams and recommending to players.
Expected Outcomes	• Provide Unique Character Development Experiences for Each Player • Offer optimal matchmaking for players This initiative contributes to the spread of next-generation quantum technologies and expansion in the entertainment market.
Keywords	Nurturing, matchmaking, quantum optimization

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Creation of Next-Generation Music Experience Using Quantum Technology

Background	Traditional music creation is based on shaping digital waveforms and sampling processes using classical computers. However, these methods have limitations in enhancing sound quality and user experience. Music generation using quantum mechanical time evolution processing or wave function calculations offers unprecedented high-quality acoustic experiences.Moreover, J-POP enjoys high popularity domestically but faces limited acceptance in international markets, particularly in English-speaking regions. Success internationally requires evolving J-POP's unique characteristics into forms with international compatibility. Utilizing quantum computers to optimize melody and lyrics harmony and analyzing international listeners' sensibility data to create diversity-conscious music is anticipated.
Content	1. Music Generation Using Quantum Mechanics Theory Develop new music generation methods using physical models based on quantum mechanics, utilizing wave function calculations on quantum circuits. Aim for quality enhancement in quantum music and user experience innovation. Additionally, explore educational effects through the interaction between music and quantum mechanics. 2. Internationalization of J-POP and Utilization of Quantum Computers Develop algorithms to optimize harmony between J-POP melody structures and English lyrics rhythms using quantum computers. Additionally, propose methods for creating music considering cultural diversity through analyzing international listener sensibility data, aiming to realize lyrics blending nuances and phonetics via translation technology advancements.
Example of Quantum Technology	1. Quantum Simulation and Quantum Algorithms Utilizing quantum computer wave function simulations can physically model sound or music generation. This might create complex acoustic patterns, offering new musical experiences unattainable by conventional music generation tools. Additionally, using quantum algorithms might explore new methods or patterns in music generation processes, potentially producing creative music. Especially leveraging the probabilistic nature of quantum mechanics may create unpredictable, original music. Furthermore, visualizing quantum mechanics concepts through music generation potentially serves as educational tools, developing materials for experiential learning of quantum mechanics principles through music, anticipated to contribute to science education. 2. Quantum Optimization, Data Analysis, Quantum Machine Learning Leveraging the combinatorial optimization capabilities of quantum computers might optimize melody structures and lyric rhythms, enabling the creation of internationally compatible music. This might promote acceptance of J-POP in international markets. Additionally, harnessing quantum computers' fast data processing capabilities to analyze international listener sensibility data might create music addressing diverse cultural backgrounds. This enables music production aligned with target market needs. Advancements in natural language processing technology using quantum computers may realize harmony between nuances and phonetics in lyric translation across different languages.
Expected Outcomes	• Music generation using quantum mechanics provides high-quality musical experiences beyond conventional methods. Furthermore, educational learning effects of quantum mechanics through music are anticipated, promoting a new fusion of science and art. • Harmony between melody and lyrics enabling international acceptance of J-POP is realized, establishing new methods for conveying Japan’s cultural value globally. This contributes to advancing the Cool Japan strategy, enhancing J-POP's presence in international markets.
Keywords	Music generation, J-POP, next-generation music experience, sensibility data analysis, quantum simulation, quantum optimization

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Improvement of Happiness Through Quantum Entanglement Matching App

Background	In modern society, the quality of human relationships is deeply linked to life happiness levels. However, existing matchmaking technologies mainly rely on statistical approaches and are limited in analyzing connections based on emotions and deep psychology.
Content	Realize "quantum compatibility analysis" based on biometric data (brain waves, heart rate, emotional data, etc.). This aims to build deep human relationships unattainable by conventional technologies. Specific initiatives are as follows: 1. Develop algorithms using quantum computers to analyze biometric data, such as brain waves and heart rate, collected from wearable devices and reveal the interrelations of emotions and cognition.
Example of Quantum Technology	1. Analysis of Biometric Data using Quantum Computers Quantum machine learning may be utilized in analyzing biometric data such as brain waves and heart rate. This is expected to realize the development of algorithms that evaluate the quality of human relationships.
Expected Outcomes	• Provide Optimal Compatibility Scores to Users for Building Deeper Human Relationships • Expand Application Possibilities in Business and Education, in Addition to Romantic Matching • Creation of New Markets and Promotion of Quantum Computer Adoption Through this initiative, new approaches to improving the quality of human relationships are offered, expecting enhanced society-wide happiness.
Keywords	Matchmaking Technology, Quantum Compatibility Analysis, Quantum Entanglement, Quantum Machine Learning

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DX in Fashion Industry and Strengthening Japan's Soft Power

Background	Although Japan's fashion industry is highly regarded both domestically and internationally, it faces challenges in adapting to rapidly changing consumer trends and efficiently managing its supply chain. Of particular concern are inventory management deficiencies and environmental burdens due to overproduction. Sustainable business growth requires more accurate demand forecasting and supply chain optimization.
Content	Develop demand forecasting systems and supply chain optimization methods utilizing quantum computer capabilities to achieve the following: 1. Ultra-Early Trend Prediction: Use quantum machine learning to rapidly analyze consumer preferences and market trends, predicting trends. 2. Dynamic Optimization of Logistics and Production Planning: Utilize quantum algorithms at each stage of the supply chain, adjusting inventory management and production planning. 3. Comprehensive Evaluation of Environmental Load: Assess environmental impacts at each process from production to consumption, constructing sustainability-conscious business models.
Example of Quantum Technology	1. Quantum Machine Learning Quantum machine learning may quickly extract patterns from datasets and aid in predicting consumer preferences and market trends. Quantum computers can efficiently process data with complex relationships, potentially allowing rapid prediction of fashion trends. 2. Quantum Optimization Using quantum optimization can enhance efficiency at each stage of the supply chain (production, distribution, inventory management). This prevents overproduction and inventory shortages. Additionally, continually monitoring the supply chain situation and planning optimal production and delivery based on quantum optimization is expected to swiftly respond to dynamic market changes.
Expected Outcomes	• Improved Trend Forecasting accuracy enables waste-free production and sales, reducing inventory costs. • Optimize the supply chain to achieve efficient logistics and production, reducing lead time. • Reduce environmental burden and establish a sustainable fashion business model. • Strengthen competitiveness of Japan's fashion industry and enhance its standing in international markets.
Keywords	Fashion industry, supply chain management, trend forecasting, dynamic optimization of logistics and production planning, quantum machine learning, quantum optimization

Optimization of Advertisement Location Selection: Overcoming Human Selection Challenges and Maximizing Advertisement Effectiveness

Background	Effective location selection for advertisements is required to enhance tourist spending. However, the current selection process relies primarily on human visual inspection, leading to challenges with subjective judgments and inefficiencies. Additionally, pedestrian flow data and information on advertising effectiveness are insufficiently utilized, making optimal ad location selection difficult.
Content	Develop algorithms to optimally select advertising locations using quantum computers, based on pedestrian flow and beacon interaction data. By using quantum computers, swiftly identify optimal advertising locations from numerous candidates to maximize advertising effectiveness.
Example of Quantum Technology	1. Quantum Optimization Using quantum optimization, efficiently select optimal advertising locations from numerous candidates. 2. Data Processing and Analysis Using Quantum Computers By integrating pedestrian flow data and beacon interaction data, and applying quantum machine learning to data like flow patterns and target customer routes at each candidate location, it may be possible to extract patterns of consumer behavior and ad effectiveness and construct models predicting advertising effectiveness.
Expected Outcomes	Utilizing optimization algorithms on quantum computers, overcome subjective selections from traditional visual inspections, enabling objective and efficient ad location selection based on data. This is expected to maximize reach to target audiences and enhance the effectiveness of ad-driven visitor engagement.
Keywords	Tourism, advertising, advertising-driven engagement effectiveness, pedestrian flow data, consumer behavior, quantum machine learning, quantum optimization

Multi-Purpose Optimization for Circular Economy in Chemical and Material Industries Using Quantum Computers

Background	In the chemistry and materials fields, achieving product sustainability through resource recycling within a circular economy is sought. To realize this, formulating development strategies that balance emission reduction, material circularity, and economic feasibility is crucial. Particularly, strategies are necessary to multi-objectively optimize parameters across different scales such as material design, process design, supply chain design, economic viability, and contribution to the planet.
Content	This issue explores methods to efficiently address multi-objective optimization problems within a circular economy using quantum computers. Specifically, concerning Pareto front calculations, traditional methods require numerous evaluation function calls, exponentially increasing computational load. Additionally, referencing "inferior solution sets" beyond the Pareto front solves the increased computational load for understanding the current position, entire solution space, Pareto front shape, and model validity.
Example of Quantum Technology	1. Quantum Optimization Using quantum optimization may enable solving multi-objective optimization problems within a circular economy. 2. Quantum Machine Learning Using quantum machine learning, extracting key features from design models within a circular economy and validating their viability is anticipated.
Expected Outcomes	The goal of this project is to develop quantum algorithms for multi-objective optimization in a circular economy using quantum computers. This is expected to significantly improve computational efficiency compared to conventional methods. The problem scale at POC (proof of concept) level is acceptable, but successful implementation could greatly contribute to sustainable development in the chemical and materials industries.
Keywords	Chemistry and Materials field, Circular Economy, Pareto Front, Quantum Optimization