Complex Risk Landscape and Importance of AI / Big Data:

Perspectives from Japan

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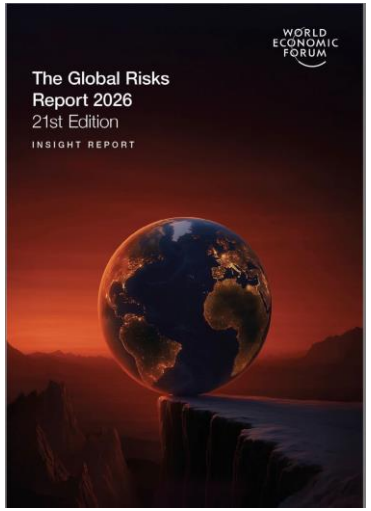
Short and long-term risks



Context 1: Global Risk Landscape

(World Econmic Forum)

Environmental risk (disaster, climate change, Biodiversity loss) remains top

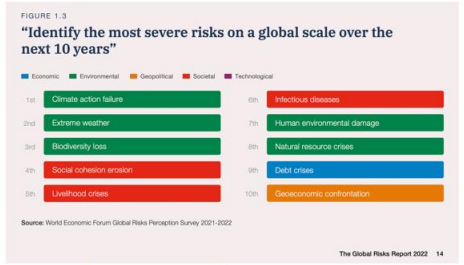
Complex risk landscape with New risks

- *Infectious disease*
- *Digital divide*
- Digital power concentration
- Cyber security
- *Energy crisis*
- Food pricing

Need for inclusive risk reduction

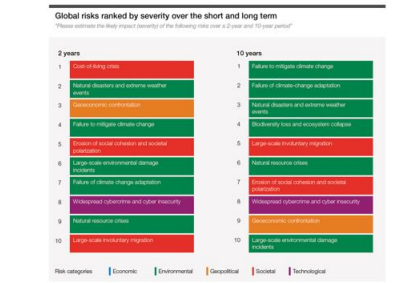
Environmental risk 2020

Infectious disease / Digital divide 2021



2022 *Cyber security*

2023 *Energy crisis*

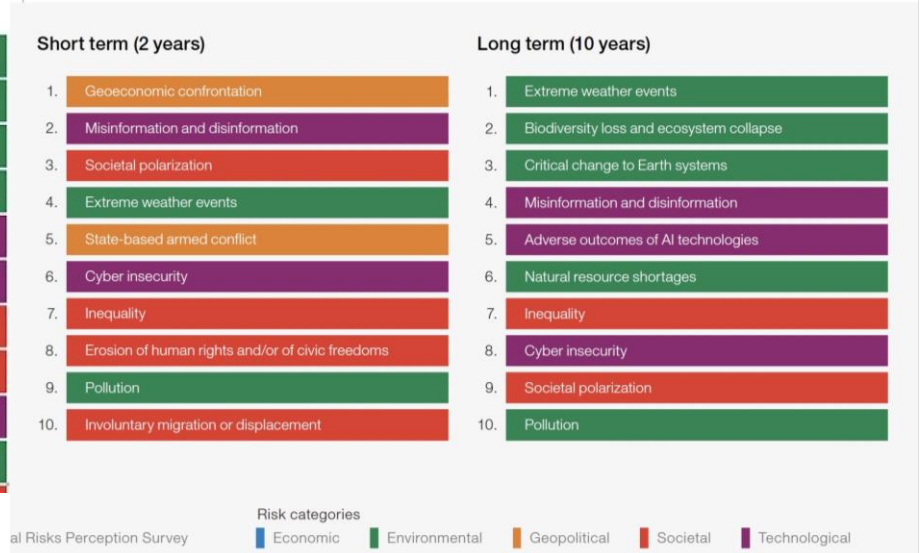


2024

2025

2026

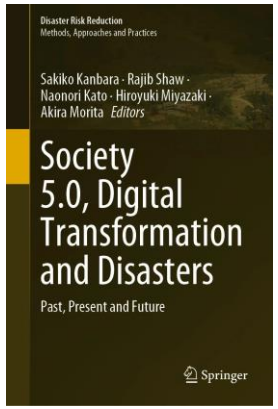
Global Risk Outlook World Economic Forum

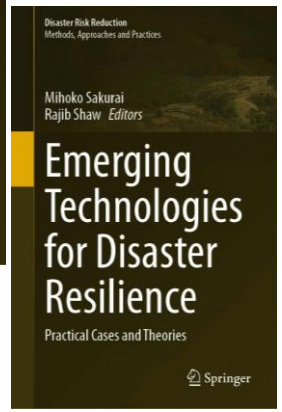


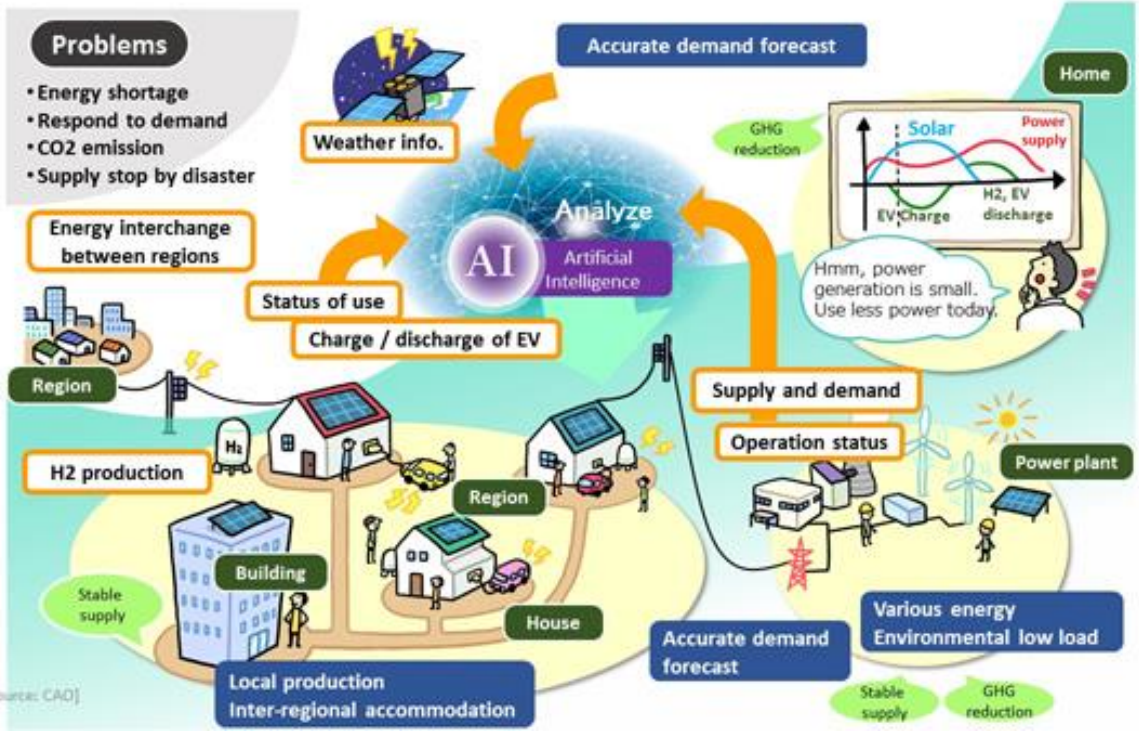
Society 5.0:

2017 Science and Technology Basic Plan

Human-Centric Technology-Driven Society







AI Development in Japan

Alignment with OECD AI Principles (founding supporter).

2019: Social Principles of Human-centric AI (Draft).

2019: AI Strategy 2019 (AI for Everyone: People, Industries, Regions and Governments).

2017~2020

Japan Deep Learning Association (JDLA) Certificate.

Rapid expansion of AI startups: Preferred Networks, Abeja, Cinnamon AI.

Toyota builds Woven City (AI-driven smart society prototype).

2021: Digital Agency established.

2022: AI R&D Guidelines for Human-Centric Society; AI Strategy 2022.

2023: G7 Hiroshima Process for “safe & trustworthy AI”.

2025: Government invest over ¥10 trillion allocated to support AI and semiconductor technologies.

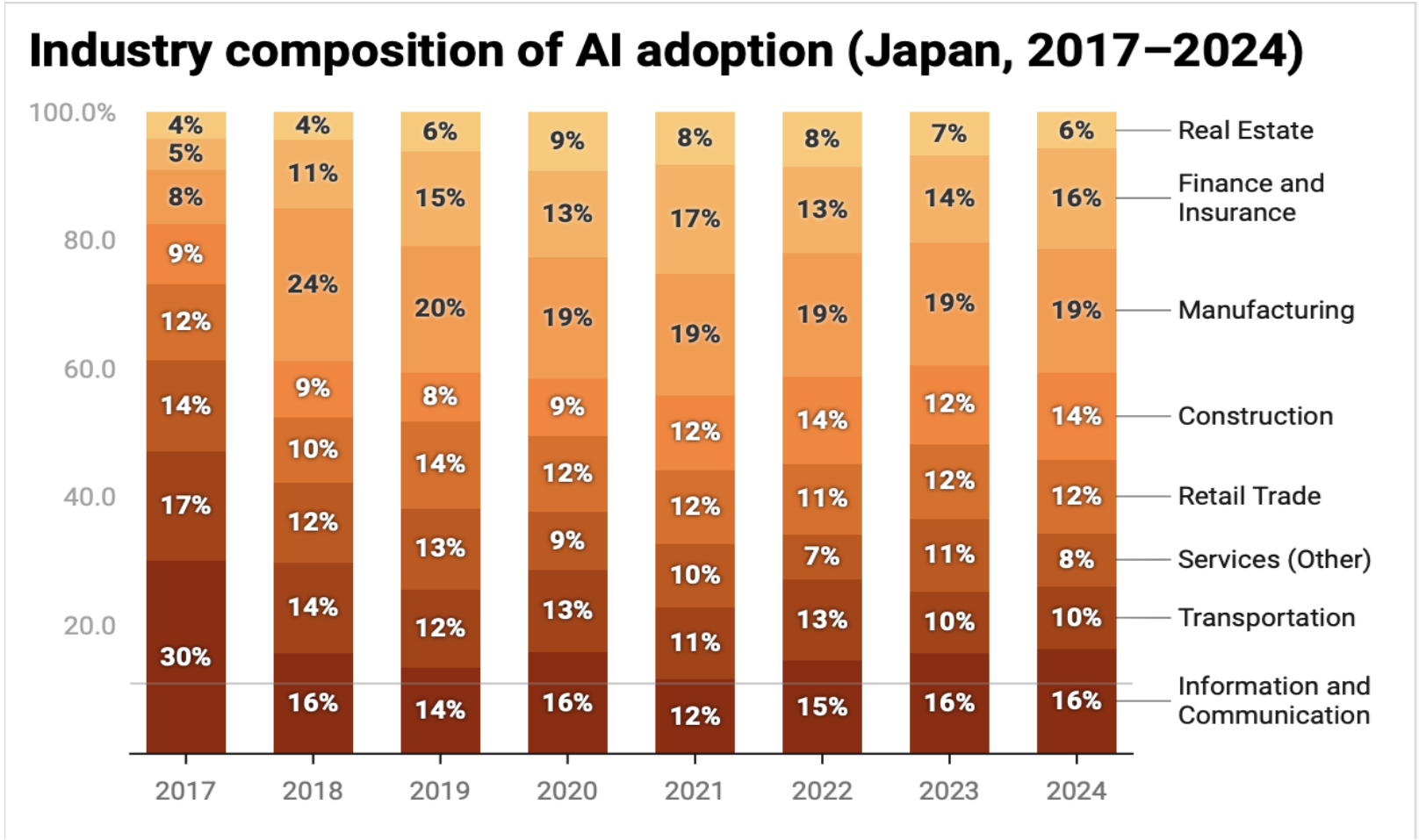
2021~2025

Sustainability NGOs rise& AI ethics.

Fujitsu, NEC, NTT develop proprietary LLMs (Japanese-optimized).

Companies begin integrating generative AI to address labor shortages.

AI ADOPTION IN GENERAL in Japan



This chart shows among firms that have adopted AI, what share comes from each industry (summing to 100% each year)

Data source：https://www.e-stat.go.jp/

Key Findings

Concentrated in ICT→ More diversified mix.

AI spreads gradually beyond early-ready sectors because benefits require complementary investments.(Brynjolfsson, 2021)

Manufacturing becomes a steady pillar among adopters.

AI can provide rapid and scalable value on the production site - predictive maintenance and quality control enhance equipment uptime and output.

AI / Big Data Applications in Disaster Management

- Predictive Analytics
  - AI models analyze large datasets for disaster prediction (e.g., earthquakes, floods, wildfires)
  - Early warning systems based on weather, geospatial, and environmental data
- Real-time Monitoring
  - Drones, sensors, and satellite data processed by AI for real-time risk detection
  - AI-powered monitoring of social media and news for disaster-related information

AI in Pre-disaster preparedness

- Risk Mapping: AI analyzes geographical and historical data to map high-risk zones
  - Useful in urban planning and infrastructure development
- Resource Optimization: AI helps in pre-positioning resources like food, medical aid, and rescue teams in vulnerable areas
  - Improves logistics planning for disaster scenarios
  - TKB 48 (Toilet, Kitchen, Bed)

AI in Disaster Response

- Real-time Decision Making: AI analyzes data from affected areas to support rapid decision-making
  - Identifies optimal evacuation routes and areas in need of urgent help
- Search and Rescue: AI-equipped drones and robots for locating survivors in hard-to-reach places
  - Autonomous vehicles for delivering supplies to disaster zones
- Crowdsourced Data Analysis: AI processes data from citizens via mobile apps to prioritize response actions

AI in Post-Disaster Recovery

Damage Assessment: AI analyzes satellite imagery and drone footage to assess damage quickly

Accelerates insurance claims and government aid

Rebuilding with AI: AI models suggest better reconstruction plans based on past disaster patterns

Helps build more resilient infrastructure

Some examples of AI use in Japan

Preparedness

- Extreme weather events and tsunami flooding: **Supercomputer Fugaku** is being used to run high-resolution simulations for precise prediction.
- River level forecasting**:** Companies like Fujitsu and Nippon Koei have developed **deep learning models** that use historical rainfall and water level data to predict river flooding several hours in advance.
- Volcanic eruptions: **AI-generated video** produced and released by the Tokyo government to prepare the residents for Mt. Fuji eruption.

During Disasters

- **Spectee Pro:** This cloud-based AI service leverages machine learning to analyze vast datasets sourced from weather sensors, river cameras, and social media platforms to provide authentic and real-time reports on disaster conditions, such as floods or road blockages and to effectively filter false information.
- **AI Chatbots:** Services like those developed by **Weathernews Inc.** utilize AI-powered chatbots on smartphones to assist citizens in locating evacuation shelters.

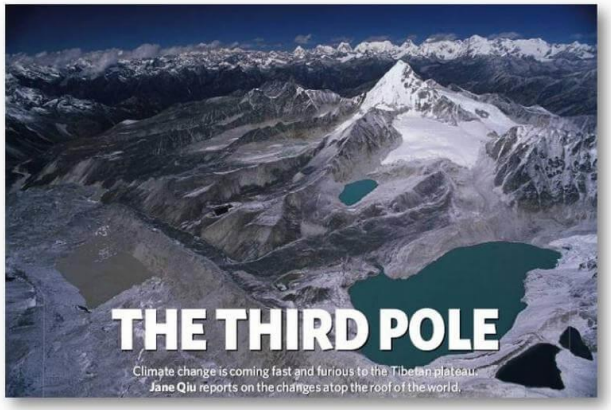
Mitigation

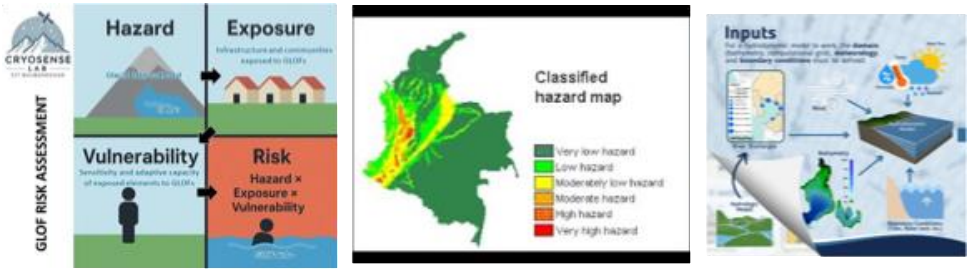
- **Project PLATEAU:** Initiated by MLIT, this project creates 3D "digital twins" of Japanese cities. By superimposing simulated **flood or landslide** data onto these models, officials can visualize disaster risks and plan more resilient urban infrastructure.
- **NTT** uses AI to predict potential damage to essential infrastructure such as power lines and pipelines by analyzing seismic data and structural sensors, allowing for **preemptive reinforcement** before a disaster strikes.
- **AI-generated contour maps show the depth of soil bearing layers, helping city planners identify areas vulnerable to liquefaction.**

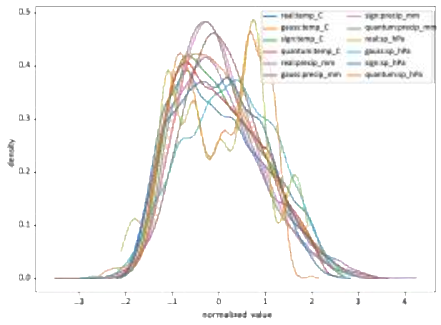
GLOF (Glacier Lake Outburst Flood)

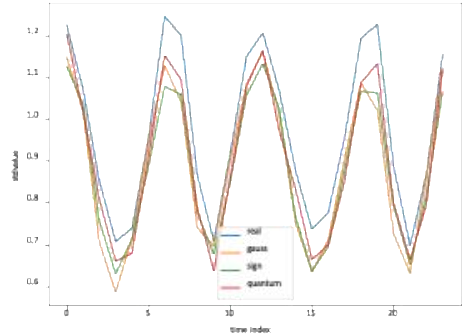
Climate Change is Accelerating GLOF Hazards

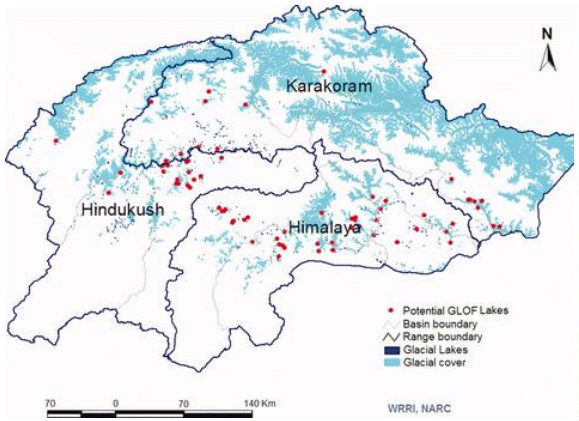
- Global warming has entered the era of "Global Boiling"
- Rapid glacier retreat is creating thousands of unstable glacial lakes
- Frequency and intensity of GLOFs are increasing worldwide
- Hindu Kush-Karakoram-Himalaya (HKH) is one of the world's most vulnerable mountain regions

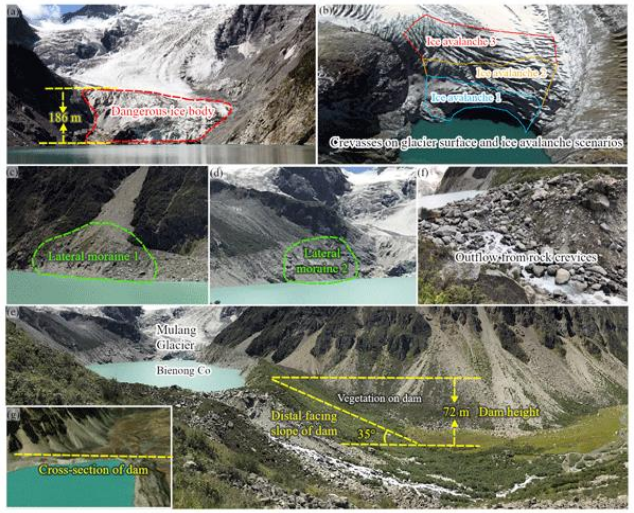












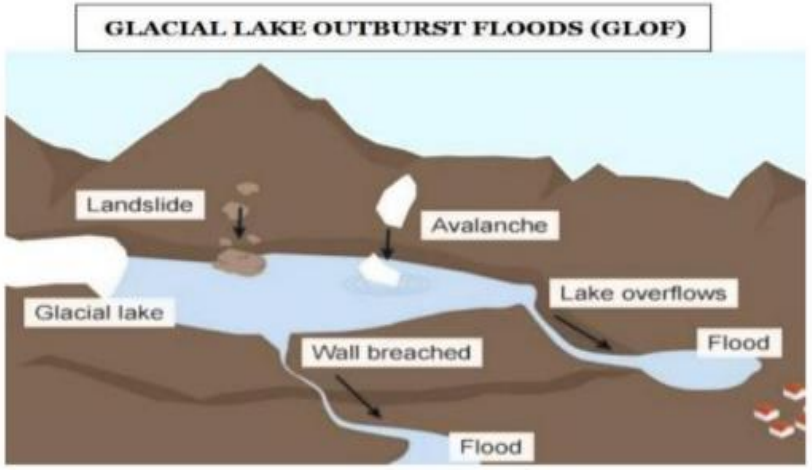
[Quantum Latent Generative Modeling] Glacial Lake Outburst Prediction

NatureSR under review

Research Article

Quantum Generative Intelligence for rare-event anomaly discovery under severe data scarcity: Applications to Glacier Lake Outburst Flood (GLOF) Risk Reduction

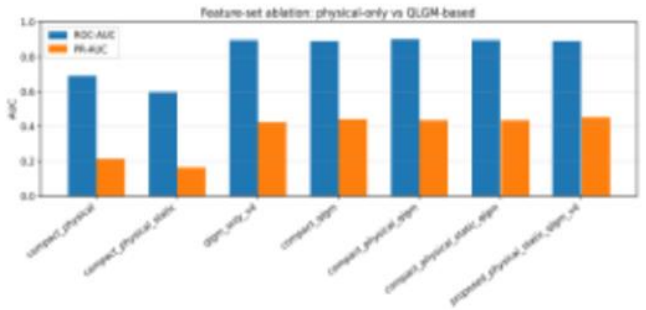
Shah Nawaz Khan, Hiroshi Yamauchi, Rajib Shaw



Quantum Latent Sequence Generation, Anomaly Scoring, and Rare Event Classification

- Trained a 24-month sequence model using a conditional Wasserstein GAN, with hydro-climatic time series and static glacier attributes as inputs.
- Compared Gaussian, sign, and quantum expectation value latents using an identical architecture to separately evaluate the contribution of latent space design.
- Trained the quantum latent generative model using only "normal" 12-month windows, and quantified deviations in amplitude, autocorrelation, frequency, and inter-variable correlations as anomaly scores.
- Fused physically relevant features, temporal/multi-scale features, and QLGM scores, evaluating the model via stratified group cross-validation across 26 glacier groups.

Metric	Gaussian	Sign	Quantum
corr_fro	1.184	1.074	**0.682**
Wasserstein	0.206	0.139	**0.109**
KS stat	0.127	0.089	**0.072**
ACF dist	0.170	0.172	**0.115**
PSD dist	11.645	11.545	**10.698**
ACF dist (base3)	0.262	0.220	**0.111**
PSD dist (base3)	1.983	1.941	**1.351**



Quantum expectation value potential represents the normal temporal structure of hydroclimatic series and has demonstrated the potential to extract deviations in autocorrelation and inter-variable correlations as anomaly signals.

Quantum Latent Representations Offer Advantages in Anomaly Detection Using Sequential Generative Modeling

Stochastic modeling/generative models and the potential of quantum latents and global environmental issues.
Implementation and demonstration in the HKH region.

Potentials and Challenges

- Speed: Faster response times due to real-time data analysis
- Accuracy: More accurate disaster predictions and assessments
- Cost Efficiency: Reduces resource wastage by optimizing disaster preparedness and response
- Scalability: AI solutions can be scaled for global disaster management

- Data Quality: AI's accuracy depends on the availability of high-quality, up-to-date data
- Ethical Concerns: Data privacy and potential bias in AI models
- Integration with Human Decision-Making: AI is a tool, but human judgment is crucial in disaster scenarios
- Big Data: Quantity versus Quality

Future

- Advances in Predictive AI: More accurate forecasts as AI models continue to improve
- Technology Integration: Link AI with other emerging technologies like Machine Learning, Big data analytics, Drones, Robotics etc.
- Collaborative Systems: AI working in tandem with human-led disaster management agencies
- AI literacy: to enhance capacities of local governments to use AI
- Global Integration: Expanding AI-based disaster management systems to less developed regions

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