日本―米国　国際共同研究「新型コロナウイルス感染症（COVID-19）により求められる新たな生活態様に資するデジタルサイエンス」 2023 年度　年次報告書	
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研究課題名（英文）	Multimodal Data Analytics and Integration for Effective COVID-19, Pandemics and Compound Disaster Response and Management
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１．日本側の研究実施体制

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２．日本側研究チームの研究目標及び計画概要

The outbreak of COVID-19 exposes several crucial problems of the infectious disease prevention and control system for both the US and Japan. (1) The early planning of medical resources allocation. People have little idea of distributing the limited medical supplies to various administrative districts, resulting in many people losing their lives. Therefore, if the distribution of medical resources demanded in different places can be perceived early before the large-scale outbreak, this problem can be solved; (2) The early prediction of infection hotspots. An infection hotspot means that many people are infected in the area relative to other areas. However, realistically, these areas' accurate locations are hard to trace even before the outbreak. The ability to accurately locate

these areas would be helpful for epidemic control. Therefore, in this year, we will continue to study how can the pandemic transmission characteristics and its economic and sociological impact be predicted. This research question will be solved as follows: (1) Estimating the economic impact of control policies based on mobility data; (2) Understand the public sentiment on COVID-19 and policies based on social media data; (3) Integral analysis on pandemic using both mobility and social media data.

3．日本側研究チームの実施概要

First, based on billions of metropolitan trajectory data and millions of financial transaction data, we proposed a framework to trace the impacts of different lockdown policies on the epidemiological performance and economic damage in the Greater Tokyo Area - the most populous metropolitan area, the largest metropolitan area economy in the world. Specifically, we completed the research plan as follows: (1) We employed big and detailed data (including 1.3 billion metropolitan trajectory data and 1.2 million financial transaction data, etc.) so that we can track individual-level activity, instead of a macro statistical number, which can afford detailed and spatialized simulation result. (2) We took the human mobility as a bridge, precisely simulate both economic loss propagation and epidemical transmission. (3) We worked out a Pareto optimal strategy, consisting of a series of policy-set, affording more flexibility than the past parameterized approaches. We found that the pandemic duration under the strictest lockdown is less about two months than that under the lightest lockdown, which makes the strictest lockdown characterize both epidemiologically and economically efficient. Moreover, based on the two-sided model, we explored the spatial lockdown strategy. We argue that cutting off intercity commuting is significant in epidemiological and economic aspects and finally helped governments figure out the Pareto optimal solution set of Lockdown strategy. This study offered fundamental support for guiding regional and national governments in designing health, social, and economic policies.

Second, we focused on proposing a knowledge transfer method for predicting human mobility during special events. These events include natural disasters such as earthquakes and typhoons, as well as outbreaks of infectious diseases, which result in unconventional patterns of human movement. Collecting data during these special events is difficult as they occur infrequently in many urban areas, resulting in limited data availability. The method involves constructing a social memory pool that stores disaster-related knowledge and utilizes a parameter-based knowledge transfer strategy to transfer the social memory pool from a source domain model to a target domain model, enabling the application of source domain knowledge for target domain prediction. The effectiveness of this method is validated through experiments, demonstrating its efficacy in the context of few-shot learning and zero-shot learning. The experimental results are analyzed to explore the method's applicability, underlying reasons for its effectiveness, and robustness.