Physics

Our laboratory consists of two staff members, and we teach physics to the Faculty of Medicine and the Faculty of Health Sciences. In our classes, we try to provide easy-to-understand explanations with many examples of physics applied to medicine. Research is carried out independently by each staff member on different topics. We try to introduce the results of our research in the classroom and to encourage students to become interested in basic research.

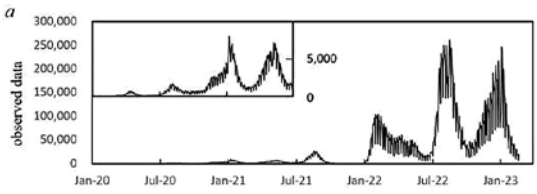
Professor
Ayako Sumi, Ph.D.
Interests: Nonlinear science

Assistant Professor
Shintaro Takatsuka, Ph.D.
Interests: Medical engineering & physics, medical information

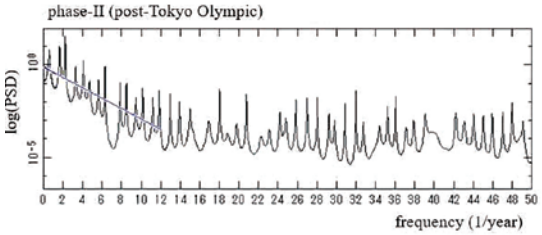
1. Research by Professor Ayako Sumi

In general, life phenomena are non-stationary and non-linear, with complex transitions from one state to another. It is not appropriate to treat entire time series containing such states. To elucidate the temporal evolution of non-linear phenomena, it is desirable to deal with segments of time series with short data lengths by segment time series analysis. There is a need for a superior time series analysis method that can elucidate the temporal variations of a time series even with short data lengths. My research group proposed a newly devised method for time series analysis that has been widely used in various fields such as medical science as well as physical science and engineering. Here, I show you an example of the application of this method to COVID-19 surveillance data of Japan (1).

(a) COVID-19 surveillance data in Japan



(b) Power spectral density



(c) Three-dimensional spectral array

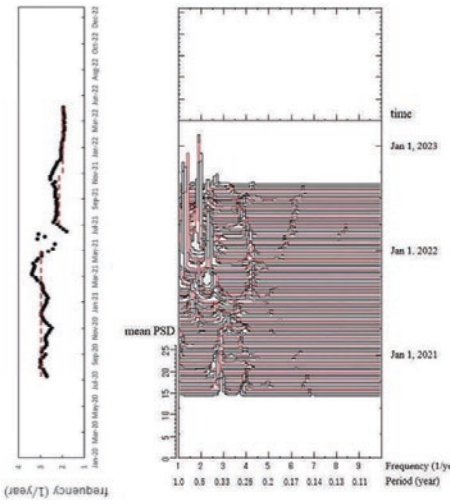


Figure. Application of the method of time series analysis to COVID-19 data in Japan: (a) Time series data of daily reported number of new positive cases of COVID-19, (b) power spectral density of the data, and (c) temporal variations of periodic structure of the time series data. (1)

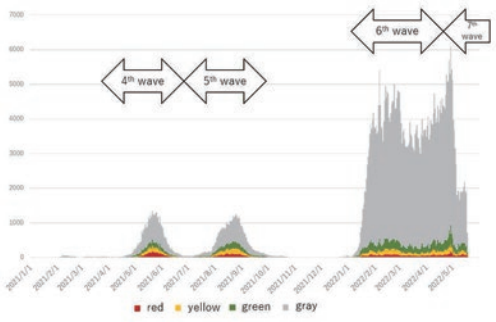
2. Research by Assistant Professor Shintaro Takatsuka

Medical data is often characterized as big data, and its collection and analysis are crucial. The Ministry of Health, Labour, and Welfare in Japan manages an extensive insurance claim dataset known as the National Database of Health Insurance Claims and Specific Health Checkups (NDB). We primarily analyze healthcare data in Hokkaido using a portion of this dataset. The NDB includes information such as visited medical institutions, disease names, medical expenses, age, and gender, contributing to research insights into regional variations and temporal changes. However, one challenge we face is the difficulty in obtaining accurate individual aggregations or precise patient statuses.

Ensuring accuracy is vital when collecting a large volume of data. During the COVID-19 pandemic, we collaborated with health observation in Sapporo City. To achieve precise data collection, we utilized survey formats through smartphones and PCs, automatically analyzing severity to reduce the workload on Sapporo City of public health officials in Sapporo City. The collected data, numbering over 1.3 million cases from home care patients alone, has the potential to provide various insights.

Figure (d) illustrates the trend of input numbers for “Covimaru,” a health observation app used in Sapporo City, Hokkaido, from April 2021 to May 2022. The users who input data were those diagnosed as positive for COVID-19. This app automatically estimates the severity of symptoms by entering items such as body temperature, symptoms, and medical history. The severity is represented in descending order from high to low, using red, yellow, and green, with gray indicating almost no symptoms. The number of COVID-19 positive cases saw an explosive increase in 2022. However, the number of severe cases during the fourth and fifth waves in 2021 and the severity of patients from the sixth wave onwards in 2022 remained almost the same.

(d) The trend of COVID-19 positive cases in Sapporo City



List of Main Publications (September 2018 to August 2023)

See 2D Barcode below