Statistical Modeling of Spatio-Temporal Phenomena

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Hyper-dimensional data (e.g., earth observation data, point-of-sales data, and genomic data) have become observable by the development of data acquisition, transmission, and accumulation technology. Direct applications of ordinary statistical technology are, however, not always successful for such huge sizes of digital data. My interest is in research of statistical techniques and modeling to extract useful information out of enormous quantities of data. This interest includes pattern recognition for estimation of pixel-wise categories from spatio-temporal data. These research areas are further explained below.

A) Statistical modeling and analysis of spatio-temporal data

Joint research with an enterprise requires appropriate understanding of the background and analytical purpose of the target data. It will be performed in the following way: (1) proposal of various statistical models, (2) development of model estimation methods and model evaluation methods, (3) coding of software, and (4) evaluation of the method by using real data. These procedures are repeated if necessary.

For joint research to be successful, close communication with a corporate researcher is necessary and indispensable. Joint research for solving a certain issue might also lead to new statistical problems, and it is a real pleasure of joint research to overcome such problems.

B) Development of analytical methodology with multivariate data

Pattern recognition has many important applications, such as handwritten character recognition and biometric person authentication. The problem of estimating category of each pixel often occurs with spatio-temporal data. In such a case, it is important to consider the spatial dependency in the stochastic modeling and to improve the classification accuracy. As an example, the figure is a forecast of the ratio of forested areas in Hiroshima Prefecture, indicated by pixels, according to the population and the relief energy defined by the difference between maximum and minimum altitudes. The figure using spatial dependency (c) is very close to the true category (a) in comparison with that without spatial dependency (b). This shows it is important to implement spatial dependency in modeling. In general, modeling and its application to environmental data is my research topic.

I am also interested in the shrinkage method for regression models. The shrinkage estimator based on the L_1 norm produces good forecasts. In addition, nonlinear regression and multiple objective variables are important research topics.

Figure: Estimation of forest-coverage ratios in Hiroshima pref.

(a) True categories (b) Without spatial dependency (c) With spatial dependency