Waseda International Symposium

Recent Developments for Statistical Asymptotic Theory for Time Series & Circular Distributions

Date: October 23 - 25, 2017

Venue:
Waseda University, Nishi-Waseda Campus, Building 63, 1st Floor, Math & Applied Math Metting Room

Organizer: Masanobu Taniguchi (Research Institute for Science & Engineering, Waseda University)

Supported by
Kiban (A-15H02061) & Tokutei-Kadai (B)

Waseda International Symposium

"Recent Developments for Statistical Asymptotic Theory for Time Series & Circular Distributions"

Date: October 23 - October 25, 2017.

Venue: Waseda University, Nishi-Waseda Campus, Building 63, 1st Floor, Math & Applied Math Meeting Room
(Access map: http://www.sci.waseda.ac.jp/eng/access)

Organizer: Masanobu TANIGUCHI
(Research Institute for Science & Engineering, Waseda University)

Supported by

(1) Kiban (A-15H02061) M. Taniguchi, Research Institute for Science & Engineering, Waseda University

(2) Tokutei-Kadai (B) M. Taniguchi, Research Institute for Science & Engineering, Waseda University

Program (*Speaker)

October 23

Session (I): 13:30 - 15:20: chaired by Estate Khmaladze

13:30 - 13:40: Opening
Masanobu Taniguchi (Waseda Univ.)

13:40 - 14:30:
Self-weighted GEL method for linear hypothesis in infinite variance processes and its application to change point tests
Fumiya Akashi (Waseda Univ.), Holger Dette and Yan Liu

14:30 - 15:20:
Time Series Analysis for Cylindrical Data with its Application to Wind Speeds and Directions
Takayuki Shiohama (Tokyo Univ. of Science)

15:20 - 15:30: Coffee break

Session (II): 15:30 - 17:10: chaired by Ming-Yen Cheng

15:30 - 16:20:
Joint circular distributions in view of higher order spectra of time series
Masanobu Taniguchi, Shogo Kato, Hiroaki Ogata (Tokyo Metropolitan Univ.) and Arthur Pewsey*

16:20 - 17:10:
Empirical processes and unitary operators

Estate Khmaladze (Victoria Univ. of Wellington)

October 24

Session (III): 9:30 - 10:30: chaired by Fumiya Akashi

9:30 - 10:00:
Asymptotic theory of Whittle estimation for high-dimensional time series
Yoshiyuki Tanida (Waseda Univ.), Fumiya Akashi and Masanobu Taniguchi*

10:00 - 10:30:
Modified LASSO estimators of the models with long-memory
Yujie Xue (Waseda Univ.) and Masanobu Taniguchi*

10:30 - 10:40: Coffee break

Session (IV): 10:40 - 12:00: chaired by Hiroaki Ogata

10:40 - 11:10:
Analysis of variance for high dimensional time series
Hideaki Nagahata (Waseda Univ.) and Masanobu Taniguchi*

11:10 - 12:00:
Regularized noise-reduction methodology in high-dimensional settings
Kazuyoshi Yata (Univ. of Tsukuba) and Makoto Aoshima*

12:00 - 13:20: Lunch

Session (V): 13:20 - 15:00: chaired by Yury Kutoyants

13:20 - 14:10:
A Bayesian network model for linear–circular data
Ignacio Leguey, Concha Bielza, Pedro Larrañaga and Shogo Kato (Institute of Statistical Mathematics)*

14:10 - 15:00:
Asymptotic Properties of Mildly Explosive Processes with Locally Stationary Disturbance
Junichi Hirukawa (Niigata Univ.) and Sangyeol Lee*

15:00 - 15:20: Coffee break

Session (VI): 15:20 - 17:00: chaired by Masanobu Taniguchi

15:20 - 16:10:
Extensions of the self-exciting model and causality analysis for seismicity
Yoshihiko Ogata (Institute of Statistical Mathematics)

16:10 - 17:00:
On frequency estimation for diffusion processes: a survey
Yury Kutoyants (Univ. du Maine)

17:30 - : Buffet Party

October 25

Session (VII): 9:30 -10:20: chaired by Yan Liu

9:30 - 10:20:
On estimating finite mixtures of sine-skewed circular distributions
Toshihiro Abe, Takayuki Shiohama and Yoichi Miyata (Takasaki City Univ. of Economics)*

10:20 - 10:30: Coffee break

Session (VIII): 10:30 - 12:10: chaired by Junichi Hirukawa

10:30 - 11:20:
Asymptotics of test statistic for sphericity of high-dimensional time series without diagonalizability condition
Yan Liu (Waseda Univ.), Yurie Tamura and Masanobu Taniguchi*

11:20 - 12:10:
A simple and adaptive two-sample test in high dimensions
Ming-Yen Cheng (Hong Kong Baptist Univ.)

Abstracts

Self-weighted GEL method for linear hypothesis in infinite variance processes and its application to change point tests

Fumiya Akashi, Holger Dette and Yan Liu*

Abstract: This talk constructs the testing procedure of linear hypothesis on the coefficients of ARMA processes, which may have infinite variance. When the model is generated by a heavy-tailed innovation process, it is when known that the rate of convergence and the limit distribution of fundamental statistics contains unknown tail-index of the error distribution, and it is unfeasible to derive the critical value of the test in practice. To overcome the difficulties, the self-weighted generalized empirical likelihood (GEL) method is constructed, and the proposed GEL statistic is shown to converge to the standard chi-square distribution regardless of whether the model has infinite variance or not. That is, the proposed test statistic is shown to be robust against the heavy-tails of the model. Therefore, various important tests involving model diagnostics can be carried out with no prior estimation for the unknown quantity of the models such as the tail-index of the innovations. In particular, this talk also apply the self-weighted GEL method to the change point detection problem of infinite variance processes. Some simulation studies illustrate the finite sample performance of the proposed test.

Time Series Analysis for Cylindrical Data with its Application to Wind Speeds and Directions

Takayuki Shiohama

Abstract: In this study, we will introduce some approaches to the time series modeling for cylindrical data. The first approach is modeling wind directions with time-varying concentration parameter for circular Markov processes. These time-varying parameters are determined by exogenous variables such as wind speed through an unknown function. A nonparametric method based on maximum likelihood estimation is considered and its asymptotic normality is shown. The second approach is to consider the state space form of the cylindrical time series. The wind speeds and directions have complex time series probability structures involving highly non-Gaussian and nonlinear transition. We consider a simulation-based inference using the sequential Monte Carlo methods for computing the posterior distributions for the state variables given all available observations.

Joint circular distributions in view of higher order spectra of time series

Masanobu Taniguchi, Shogo Kato, Hiroaki Ogata and Arthur Pewsey*

Abstract: The objective of this paper is to link spectral densities of stationary time series and circular density functions. Circular data are represented by the point on a unit circle. Therefore, its density is defined by a nonnegative function on [0, 2π]. Spectral densities are Fourier transform of the autocovariance functions of the stationary processes, which is also a nonnegative function on [0, 2π]. We point out the existing spectral density families include several circular density models. We also introduce the higher order spectral density, and suggest that it could be regarded as a joint circular density functions.

Empirical processes and unitary operators

Estate Khmaladze

Abstract: Given a sequence $X_1,\ldots, X_n$ of i.i.d. (F) random variables,

we consider function-parametric empirical process

$$v_{n,F}(\phi) = \frac{1}{\sqrt{n}} \sum_{i=1}^{n} \phi(X), \quad \phi \in L_2(F),$$

and then investigate its transformations by unitary operators U:

$$U^* v_{n,F}(\phi) = v_{n,F}(U\phi).$$

The class of processes, which can be obtained in this way, is remarkably interesting and useful.One consequence of such transformations is a distribution free theory of testing for very broad classes of statistical hypotheses. Namely, groups of unitary operators can be constructed which map the empirical processes in one testing problem to the empirical processes in many other testing problems, thus making all these problems equivalent. Applications to other problems, not necessarily connected with i.i.d. observations – for example, those connected with point processes, seem to us possible, but have not been explored yet.

Asymptotic theory of Whittle estimation for high-dimensional time series

Yoshiyuki Tanida, Fumiya Akashi and Masanobu Taniguchi*

Abstract: This paper discusses the asymptotics of Whittle functional and Whittle estimator based on thresholded periodogram matrices of n observations from p dimensional non-Gaussian stationary processes. In the past few decades, several authors applied various methods to the sample autocovariance matrix, including the thresholding estimator, of high-dimensional Gaussian and dependent processes. However, it is often severe to assume independence or Gaussianity for observations in practical situation. In this paper, the classical results will be extended to those of non-Gaussian dependent case. Concretely, for non-Gaussian high-dimensional stationary processes, we elucidate the rate of convergence of the thresholding estimator, asymptotics of Whittle functional and Whittle estimators. Simulation experiments are also given, and we observe

that the proposed estimators perform well. It may be noted that the asymptotics of the proposed estimators are described in terms of non-Gaussian quantities, which show an importance of the results.

Modified LASSO estimators of the models with long-memory
Yujie Xue and Masanobu Taniguchi*

Abstract: When we deal with actual problems by model building, it is often commonly assumed that the response variable and covariates satisfy linear relationship. One of the usual assumptions is that the disturbances follow identically independent distribution. Nevertheless the correlation of them may occur when the data are collected sequentially in time, especially in the field of economics and geophysics. In this talk, we consider a linear regression model under the Grenander conditions and assume the disturbances are strongly dependent. Then the asymptotic theory for modified LASSO estimators is discussed. It is shown that when there is no jump for the diagonal members of a Hermitian matrix function, which is decided by the Grenander conditions, the standardized form of the estimator has similar asymptotical properties to the case of independent disturbances. Besides, when the jumps exist, under certain conditions, the standardized form of the modified estimator is asymptotically normal.

Analysis of variance for high dimensional time series
Hideaki Nagahata and Masanobu Taniguchi*

Abstract: For independent observations, analysis of variance (ANOVA) has been enoughly tailored. Recently there has been much demand for ANOVA of high dimensional and dependent observations in many fields. For example it is important to analyze differences among industry averages of financial data. However ANOVA for high dimensional and dependent observations has been immature. In this paper, we study ANOVA for high dimensional and

dependent observations. Specifically, we show the asymptotics of classical tests proposed for independent observations and give a sufficient condition for them to be asymptotically normal. Some numerical examples for simulated and radioactive data are given as applications of these results.

Regularized noise-reduction methodology in high-dimensional settings

Kazuyoshi Yata and Makoto Aoshima*

Abstract: In this talk, we consider PCA methods in high-dimensional settings. We first consider asymptotic properties of the conventional estimator of eigenvalues. We show that the estimator is affected by the high-dimensional noise structure directly, so that it becomes inconsistent. In order to overcome such difficulties in a high-dimensional situation, Yata and Aoshima (2012, JMA) developed a new PCA method called the noise-reduction (NR) methodology. We show that the NR method can enjoy consistency properties not only for eigenvalues but also for PC directions in high-dimensional settings. The estimator of the PC directions by the NR method has a consistency property in terms of an inner product. However, it does not hold a consistency property in terms of the Euclid norm. With the help of a thresholding method, we modify the estimator and propose a regularized NR method. We show that it holds the consistency property of the Euclid norm.

A Bayesian network model for linear–circular data

*Ignacio Leguey, Concha Bielza, Pedro Larrañaga and Shogo Kato**

Abstract: In numerous academic fields, it is common that multivariate data include circular observations which can be expressed as angles or points on the circle. Because of the periodic nature of circular observations, a direct application of ordinary Bayesian network techniques could lead to an erroneous result in analysis. We propose

a tree-structured Bayesian network model for linear–circular data, namely, data comprising of multiple linear and circular observations. The proposed model is defined using marginals and conditionals of the following three bivariate models: the bivariate normal distribution, the bivariate wrapped Cauchy distribution, and a bivariate distribution on the cylinder. There is an efficient algorithm for random generation of the presented Bayesian network model. The mutual information for the joint distributions of parent and child variables can be expressed in a simple and closed form. Maximum likelihood estimation of the parameters is efficient for the marginals and conditionals related to parent and child variables. There are closed-form expressions for the method of moments estimators of the parameters. The presented Bayesian network model can be estimated based on the mutual information via Chow Liu algorithm.

Asymptotic Properties of Mildly Explosive Processes with Locally Stationary Disturbance

Junichi Hirukawa and Sangyeol Lee*

Abstract: In this talk the limit distribution of the least squares estimator for mildly explosive autoregressive models with locally stationary disturbance is established, which is shown to be Cauchy as in the i.i.d. case. The result is then applied to identify the onset and the end of an explosive period of a financial time series. Simulations and data analysis are conducted to demonstrate the validity of the result.

Extensions of the self-exciting model and causality analysis for seismicity

Yoshihiko Ogata

Abstract: Occurrence times of earthquakes can be considered to be a point process, and suitable modelling of the conditional intensity functions of point process is useful for the investigation of various

statistical features in seismic activity. This talk start with Hawkes self-exciting point process model and introduce various extended versions for analysis of seismicity data. These will also provide hints of the similar modelling in other research fields such as infectious disease, neurophysiology systems, finance transactions and crime. Tectonically, some seismic causality can be understood due to conveyed stress changes. The cross-correlation study between two point process data sets and is quantified by the cross Palm intensity. However, the analysis of the causality using the cross-correlation is affected by clustering of events. Therefore I have been applied extended Hawkes self-exciting models which include the epidemic-type aftershock sequence (ETAS) model. Furthermore, many earthquake prediction techniques have been proposed on the basis of geophysical anomalies of various types. However, the effectiveness of these techniques is controversial. Therefore, objective evaluation methods are required for such techniques. In particular, we should provide statistical significance of a causal mechanism and assessment of probability against the standard seismicity model in the target area. In this respect, the model can be used to investigate the statistical relation between geophysical anomalies, as suspected precursor signals, and large earthquakes.

On frequency estimation for diffusion processes: a survey
Yury Kutoyants

Abstract: The problem of frequency estimation is of special interest in telecommunication theory and in statistical radio physics. For example, the shift of the frequency allows to estimate the speed of the object (Doppler effect). We suppose that the trend coeffcient has a periodic in time component with unknown period (frequency). We consider the problem of estimation of this frequency in the following situations: a) deterministic signal in white Gaussian noise, b) additive periodic component in the drift coefficient, c) multiplicative periodic component in the drift of the partially observed nonhomogeneous linear systems. We describe properties of the maximum likelihood

estimators and Bayes estimators in the *large samples* and *small noise* asymptotics. It was shown that these estimators in regular situations are consistent and asymptotically normal. In non regular situations the rates and the limit distributions are different.

On estimating finite mixtures of sine-skewed circular distributions
*Toshihiro Abe, Takayuki Shiohama and Yoichi Miyata**

Abstract: In this talk, we provide a flexible mixture modeling framework using the sine-skewed circular distributions. A feasible EM algorithm is developed for finding the maximum likelihood estimates of parameters for a finite mixture of the sine-skewed circular distributions. In addition, a set of conditions is presented to ensure consistency of the maximum likelihood estimator in a finite mixture of the sine-skewed wrapped Cauchy distributions. The problem of estimating the model parameters will be also shown.

Asymptotics of test statistic for sphericity of high-dimensional time series without diagonalizability condition
Yan Liu, Yurie Tamura and Masanobu Taniguchi*

Abstract: We consider the testing problem for the sphericity hypothesis regarding the covariance matrix of high-dimensional time series without diagonalizability condition. Recently, test statistics for sphericity of independent and identically distributed high-dimensional random variables have been studied under the condition that both the sample size n and the dimension p diverge to infinity. A test statistic for sphericity has been proved to be well-behaved even when p is larger than n. We investigate the test statistic under the situations of high-dimensional time series. The asymptotic null distribution of the test statistic is shown to be standard normal when the observations come from Gaussian stationary processes. In the simulation study, we illustrate the properties of the test statistic for several high-dimensional time series models. In our empirical study,

we applied the test to the portfolio selection problem.

A simple and adaptive two-sample test in high dimensions
Ming-Yen Cheng

Abstract: Testing the equality of two means is a fundamental inference problem. For high-dimensional data, which are commonly encountered nowadays, the conventional Hotelling's T-square test either performs poorly or even becomes inapplicable. Several modifications have been proposed to address this challenging issue and shown to perform well. However, most of them are based on asymptotic normality of the null distributions of their test statistics which inevitably requires strong assumptions on the covariance structure. We study this serious issue thoroughly and propose an L2-norm based test that works under much milder conditions and even when there are fewer observations than the dimension. Specially, to cope with possible non-normality of the null distribution we employ the Welch-Satterthwaite chi-square approximation. We derive a sharp upper bound on the approximation error and use it to theoretically justify that the chi-square approximation is preferred to normal approximation, even when the null distribution is indeed asymptotically normal. Simple ratio-consistent estimators for the parameters in the chi-square approximation are given. Most importantly, while existing tests based on asymptotic normality are not, our test is adaptive to singularity or near singularity of the unknown covariance which is commonly seen in high dimensions and is the main cause of non-normality. The approximate and asymptotic powers are also investigated. Simulation studies and a real data application show that our test outperforms a number of existing tests in terms of size control, while the powers are comparable when their sizes are comparable.