Ladislav Tomášek

Confidence bands for spectral characteristics [Abstract of thesis]

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CONVERGENCE OF STOCHASTIC PROCESSES

P. LACHOUT, Institute of Information Theory and Automation, Pod vodárenskou věží 4, 182 08 Praha 8, Czechoslovakia
(19.4.1988, supervisor J.Dupačová)

The thesis is devoted to the proper definition and the possible applications of the concept of convergence of stochastic processes. The main aim consists in treating the case when the trajectories of processes do not create a metric space.

The new results of the work are contained in Section D. Section D.1 gives a martingale central limit theorem which can be used for proving convergence of finite–dimensional distributions of processes. The definition and main properties of the convergence are studied in Section D.2. General results are applied in Section D.3, D.5 and D.6 for the case where the index set M is a given subset of d–dimensional Euclidean space. The most interesting is the situation when M is d–dimensional interval 0,1 and the trajectories of processes are functions with the II.type discontinuity only (Definition D.6.1). This case is studied in Section D.6 where this generalized Skorochod space and the convergence are introduced.

Section D.7 provides tightness criterion which represents a generalization of the criterion proved by Bickel and Wichura (1971). The theoretical results of Section D are used for investigating the convergence of empirical processes in Section E.

CONFIDENCE BANDS FOR SPECTRAL CHARACTERISTICS

L. TOMÁŠEK, Institut hygieny a epidemiologie, Šrobárova 48, Praha 10
(19.4.1988, supervisor J.Anděl)

In the thesis, simultaneous confidence bands for autoregressive spectral density are derived. The joint asymptotic normality of all the parameters is the basis for solving the problem. In the literature, it has been done only for the autoregressive coefficients and the innovation variance separately. The inverse of the spectral density function in the form

$$1/f(\omega) = (1, \cos\omega, \dots, \cos p\omega)(g_0, g_1, \dots, g_p)' = h'(\omega)g$$

is studied next. The vector g here is a function of the autoregressive parameters. The spectral density estimator is given when replacing the parameters by their estimators. It is shown that the estimator $\widehat{g}$ is asymptotically normal. Then the critical values c_α satisfying the inequality

$$P(\max_{\omega}((\widehat{g}'h(\omega) - g'h(\omega))^2 / \operatorname{var}\widehat{g}'h(\omega)) \leq c_\alpha^2 \geq \alpha$$

are derived. For this purpose, it is taken into account that the maximum stated in this expression can be attained in utmost $4p$ points ω. Using Šidák's inequality and Bayes's theorem, it is shown that the above inequality holds for

$$c_\alpha = \Phi^{-1}(\frac{1}{2}\alpha^{1/4p} + \frac{1}{2}).$$

This result leads to the construction of the simultaneous confidence bands. The properties of the suggested method are illustrated in a simulation study.

The second part of the thesis deals with an extension to the twodimensional autoregressive model. The joint asymptotic normality of all the matrix parameter estimator, including the innovation variance matrix, is proved. The asymptotic behaviour of the spectral density estimator inverse is further studied. The simultaneous bands for the coherence function are set up using the expression

$$\mathcal{K}^2(\omega) = g_1' h(\omega)/g_2' h(\omega),$$

where $h(\omega) = (e^{-2pi\omega}, \dots, e^{2pi\omega})'$. It has been found that the width of these confidence bands depends on the quantity

$$c_\alpha = \Phi^{-1}(\frac{1}{2}\alpha^{1/16p} + \frac{1}{2}).$$

TWO NEW PROOF TECHNIQUES FOR INVESTIGATING THE COMPUTATIONAL POWER OF TWO-WAY COMPUTING DEVICES

P.ĎURIŠ, Výpočtové stredisko SAV, 842 35 Bratislava
(23.5.1988, supervisor J.Gruska)

Two new proof techniques for investigating the computational power of two-way computing devices are developed and presented in the thesis. One of them is a completely new technique and the second one is a generalization of the "cut and paste" technique originally used in [8].

Using the first technique we prove that two-way deterministic pushdown automata are more powerful than two-way deterministic counter automata. This method is also used by M.Chrobak in [6] for showing that two-way nondeterministic counter automata are more powerful than two-way deterministic counter automata. These two results settle two open problems posed in [4]. Our first technique is applied by Z.Galil in [3], too, for improving a result of [5].

We define a language L and prove, by virtue of the second proof technique, that any machine that recognizes L must satisfy $\mathrm{TIME}^2(n) \cdot \mathrm{Space}(n) \geq cn^3$. Our machine model allows k to read only input heads, where k is fixed, and the movement is like those of a multihead two-way finite automata. This result partially solves an open problem posed in [1,2]. Partially, since the heads are not allowed to jump. An immediate corollary of this result is that every multihead two-way finite automaton that recognizes L must have a time bound $T(n) \geq c(n^3/\log n)^{1/2}$. This result substantially improves a result of [7]. Our second proof technique is the first nondiagonalization method used for establishing the nontrivial time-space lower bound for Turing machines with two read heads on input tape [2].

REFERENCES

[1] Borodin A.B., Cook S.A., *A time-space tradeoff for sorting on a general sequential model of computation*, Proc.12th ACM STOC, Los Angeles, Calif. (1980), 294–301.