学術論文抄録—2004 年発表

Algebraic Theory of Automata and Languages

Masami Ito

World Scientific (Singapore), 197 pages (2004)

Although there are some books dealing with algebraic theory of automata, their contents consist mainly of Krohn-Rhodes theory and related opics. The topics in the present book are rather different. For example, automorphism groups of automata and the partially ordered sets of automata are systematically discussed. Moreover, some operations on languages and special classes of regular languages associated with deterministic and nondeterministic directable automata are dealt with. The book is self-contained and hence does not require any knowledge of automata and formal languages.（出版社の宣伝文から）

n-Insetion on languages

Masami Ito and Ryo Sugiura

Lecture Notes in Computer Science 2950, 213–218 (2004)

In this paper, we consider operations on languages called n-insertion and shuffle. After providing a few properties of these operations, we will deal with decompositions of regular languages into nontrivial regular languages by these operations. The existence of an algorithm to decide whether or not the shuffle closure of a regular language is regular is unknown. We will give a partial solution to this open problem

Some results on directable automata

Masami Ito and Kayoko Shikishima-Tsuji

Lecture Notes in Computer Science 3113, 125–133 (2004)

In this paper, we provide some properties of classes of regular languages consisting of directing words of directable automata and some new results on the shortest directing words of nondeterministic directable automata.

誤操作に対する正解操作を推定する操作履歴記録分析ツール

岡田 英彦*，足尾　勉，國枝和雄，島津秀雄

ヒューマンインタフェースシンポジウム 2004, 399–402 (2004.10)

本論文では，GUI アプリケーションソフトウェアや Web ページのユーザビリティ評価の一手法として，ユーザ誤操作に対して正解操作を推定可能な操作履歴記録分析手法を提案している．あるテストタスクを行う際にユーザが行った操作（ボタン，メニュー項目，ハイパーリンクの選択，フィールドへの文字列入力など）を X とし，X がそのテストタスクの正解操作履歴に含まれていれば正解操作と判定するが，含まれなければ誤操作と判定し，さらに，操作 X が行われた時点の画面に表示されている操作対象オブジェクトのうち，正解操作履歴に含まれるものを，操作 X に対する正解操作の候補とする．このためには操作されたオブジェクトの情報だけでなく，その操作が行われた時点の画面に表示されている他のオブジェクトの情報も取得できなければならず，従来手法では後者の情報が取得されていないため，誤操作に対する正解操作の候補を特定できていなかった．本稿では，操作 X の正誤判定を行うタイミングに応じて，リアルタイムに判定する方法，および，オフラインで判定する方法の 2 通りを提案し，その比較を論じている．また，正解操作候補が複数発見された場合の順位づけ方法について述べている．

The Fermi pseudo-potential in one dimension

F. A. B. Coutinho, Y. Nogami, L. Tomio and F. M. Toyama*

Journal of Physics A: Math. Gen., **37**, 10653–10663 (2004)

Wu and Yu recently examined point interactions in one dimension in the form of the Fermi pseudo-potential. On the other hand there are point interactions in the form of self-adjoint extensions (SAEs) of the kinetic energy operator. We examine the relationship between the point interactions in these two forms in the one-channel and two-channel cases. In the one-channel case the pseudopotential leads to the standard three-parameter family of SAEs. In the two channel case the pseudo-potential furnishes a ten-parameter family of SAEs.

Point interactions in one-dimensional quantum mechanics with coupled channels

F. A. B. Coutinho, Y. Nogami and F. M. Toyama*

Journal of Physics A: Math. Gen., **37**, 2989–2997 (2004)

We explore generalized point interactions in one-dimensional quantum mechanics with two coupled channels. They represent possible self-adjoint extensions of the nonrelativistic kinetic-energy operator. Assuming timereversal invariance we find a family of self-adjoint extensions with seven parameters. This can be compared with the one-channel case in which the corresponding number of parameters is three.

Teleportation of position and momentum of a quantum state in terms of a correlation function of the Gaussian type: A time dependent model

K. Saito and F. M. Toyama*

京都大学数理解析研究所講究録，1366, 177–187 (2004)

We present a time-dependent model that explicitly describes, in coordinate space, teleportation of a quantum state of position and momentum. Teleportation of an unknown quantum state is performed by means of quantum entanglement and classical communication. We assume that the quantum entanglement is expressed in terms of a correlation function of the Gaussian type that is reduced to the EPR state in the δ-function limit. We analyze an optimal situation in which a high degree of teleportation fidelity and a large teleportation probability are achieved. We also discuss a situation where the time delay due to the classical communication cannot be ignored.

Survey of long-term variability of stars
I. Reliability of magnitudes in old star catalogues

T. Fujiwara*, H. Yamaoka, and S. J. Miyoshi*

Astronomy & Astrophysics, 416, 641–646 (2004)

The comparison of visual magnitudes of stars compiled in old catalogues is expected to yield information about their long-term magnitude variations. In seven old catalogues whose historical data have been intensively compared, 2123 sampled stars have been studied, disregarding stars that we could not identify, double stars which could be misidentified, or stars observed under poor conditions, and known variable stars with large amplitude discrepancies. The independence of stellar magnitude catalogues is demonstrated by comparing seven old studies to each other, suggesting that the magnitude estimates in each catalogue reflect the brightness at each observational period. Furthermore, by comparing them with a modern star catalogue, the magnitude differences show a Gaussian distribution. Therefore, if they are sufficiently larger than the deduced standard deviations, the magnitude variations between the catalogues can be considered real. Thus, the stellar magnitudes compiled in old studies can be used as scientific data within the average intrinsic uncertainty. These seven old catalogues can be used as data for the survey of the long-term variability of stars.

上賀茂地域におけるバイオリージョナリズムに基づく地域研究とその展開

*勝矢淳雄，*齋藤萬之助

京都産業大学総合学術研究所所報　第 2 号，91～100，平成 16 年 (2004) 8 月

上賀茂地域で行なっている地元との連携による環境学習から上賀茂地域の文化と歴史に関する地域研究への展開過程とその課題について考察した．

バイオリージョナリズムに基礎をおく環境学習から地域研究への展開

*勝矢淳雄

環境衛生工学研究，第 18 巻，第 3 号，113 頁～118 頁，平成 16 (2004) 年 7 月

バイオリージョナリズムに基礎をおいて行なっている環境学習から地域研究までの地域との連携による各種の活動について，その現状と課題および将来への発展の方向について考察した．

水文化と上賀茂神社

*勝矢淳雄

下水文化研究，第 15 号，100～127頁，平成 16 (2004) 年 2 月

水文化の視点から見た上賀茂神社の成立とその意義について論じた．現在，一般に考えられている両者の関係が実は逆の関係であることを明らかにした．

Kikuchi-Kossel Diffraction Line Analysis on Crystallization in Salt-free Aqueous Colloidal Suspensions

Ikuo S. Sogami*, Tadatomi Shinohara, Mika Okuno, Toshiaki Kurokawa,
Masatoshi M. Arishiro, Takamasa Itoh, Masayuki Tanigawa*
and Tsuyoshi Yoshiyama*

Proceedings of the 3rd International Symposium on Slow Dynamics in Complex Systems, AIP Conference Proceedings Volume 708, Issue 1, edited by M. Tokuyama and I. Oppenheim (American Institute of Physics, New York, 2004), pp. 398–401

The Kikuchi-Kossel laser diffraction analysis proved that the crystallization in salt-free aqueous suspensions of highly-charged latex particles proceeds by way of the following multi-phase transitions: two-dimensional hcp structure → random layer structure → layer structure with one sliding degree of freedom → stacking disorder structure → stacking structure with multi-variant periodicity → fcc structure with (111) twin → normal fcc structure. For less concentrated suspensions (< 2 vol.%), the phase transition progresses further from the normal fcc

structure to the normal bcc structure via the bcc twin structure. In this note, we report results of the Kikuchi-Kossel line analysis on the newly discovered phase transitions at an intermediate stage from the stacking structure with multi-variant periodicity to the fcc (twin) structures.

Gravitational, Vertical Compression of Colloidal Crystals as Studied by the Kossel Diffraction Method

Tadatomi Shinohara, Hisashi Yamada, Ikuo S. Sogami*, Norio Ise
and Tsuyoshi Yoshiyama*

Langmuir, Vol. 20, No. 12, pp. 5141–5144 (2004. 6)

Availing of pillar-shaped crystals formed in dilute aqueous dispersions of colloidal silica particles (density: 2.2g/cm^3), we photographed the Kossel diffraction patterns systematically at various heights and found that body-centered-orthorhombic (bco) crystal grew with the (110) plane in parallel to the cuvette surface and the colloidal crystal was contracted vertically. The lattice constants of the crystal decreased with decreasing height and the lattice constant in the vertical direction in the lower part of the dispersion was smaller than that in the upper part. The gravitational effect is thus two-fold, namely sedimentation of particles causing isotropic contraction of crystals and vertical compression due to the small elastic constants.

Structure of Colloidal Crystals in Sedimenting Mixed Dispersions of Latex and Silica Particles

Tadatomi Shinohara, Toshiaki Kurokawa, Tsuyoshi Yoshiyama*, Takamasa Itoh,
Ikuo S. Sogami* and Norio Ise

Physical Review E, Vol. 70, No. 6, pp. 062401-1～4 (2004. 12)

We report bcc-fcc transitions of colloidal crystals in mixed aqueous dispersions of polystyrene-based latex particles (diameter: $D = 55.8$ nm) and silica particles (diameter: $D = 170$ nm). In the single systems, the silica particles formed bcc crystals and the latex particles did not crystallize. In the binary mixtures of these particles, colloidal crystals with fcc structures were found by the analysis of Kikuchi-Kossel diffraction images. Especially, the samples at low latex fractions started out as bcc structures, and then changed to fcc structures. Due to gravitational sedimentation, the lattice constant increased as the height from the bottom of the dispersion became larger. Furthermore, the lattice constant became smaller at a given silica fraction as the latex fraction increased.

Some remarks on nonlinear hyperbolic equations and systems

Mikio Tsuji（単著）

“Abstract and applied analysis”, edited by N. M. Chuong, L. Nirenberg and
W. Tutschke, pp. 355–364. (World Scientific. June, 2004)

We are interested in the global theory on the Cauchy problem for nonlinear hyperbolic equations and systems. The difficulty of this problem is the appearance of singularities in finite time,even if the initial data might be sufficiently smooth. Therefore our problem is how to extend the solution beyond the singularities. Our method is to lift the equations into the cotangent space so that the singularities would disappear. Then we have met some questions on the mathematical theory to fluid mechanics.

An Analysis of Typhoon 9807 (Vicki) Based on Surface Meteorological Records Obtained from Fire Stations

Yasuo Okuda, Hirohiko Ishikawa and Takeshi Fujii*

Journal of Natural Disaster Science, 25-2, 47–56. (2003)

Based on weather observation data collected at fire stations in the Kinki and Chubu districts of Japan, the surface structures of typhoon Vicki were investigated. There were four local, high wind areas in the Kinki district, the instantaneous wind velocity exceeding 50m/s. High winds occurred in two cases; almost simultaneously when minimum atmospheric pressures were reached and about one hour after they were recorded. A comparison of the local high wind areas and combined radar echo charts showed that the latter local high winds occurred around a rain band that formed to the rear of the center of the typhoon. Detailed surface structures of the typhoon concerned with temperature, humidity, precipitation, and atmospheric pressure were obtained. Weather observation data recorded at fire stations were shown to be very useful for analyzing the surface meteorological structures within a typhoon.

1998 年 10 月 15 日に京都市で発生した局地的豪雨の事例解析

東　邦昭*，藤井　健*

京都産業大学論集自然科学系列，33，86–103 (2004)

1998 年 10 月 15 日の夜に，京都地方気象台において 1 時間降水量 73.5 mm，3 時間降水量 139.5 mm の大雨を観測した．しかし，この 3 時間において，京都市周辺のアメダス観測所の園部町では 0.0 mm，長岡京市では 3.0 mm であり，この大雨は京都市城に限られた局地的な現象であった．このときの 850 hPa 面（高度約 1.5 km）の天気図によると，台湾付近に存在する台風 9810 号から北東方向に延びる湿舌が九州地方や四国地方にまで達していた．一方では，700 hPa

面（高度約 2.6 km）において，太平洋高気圧からの乾燥した気流が近畿地方に侵入して，対流不安定の成層状態にあった．京都市城における大雨を降らせた降雨セルについて，レーダーエコー画像上で追跡してみると，神戸市北部の六甲山付近で発生し，発達ながら約 30 km/h の速さで東北東に進み，約 1 時間後に京都市に達していた．レーダーエコーで 4 mm/h 以上の降雨強度をもった降雨セルは幅 10 km，長さ 60 km の線状降雨帯を形成しており，この南西端付近で新しいセルが次々と発生，発達しながら，東北東に進んで京都市に達している．これが 3 時間にわたって京都市において大雨を維持させたのであり，back-building 型降雨セルと呼ばれるものである．著者らは，今後の研究において，この事例における降雨セルの発生と維持の機構について調べることにする．

京都市における強風と大雨の起因となる気象擾乱について

藤井　健*

京都産業大学総合学術研究所所報，2，109–122 (2004)

京都地方気象台において，開設以来約 90 年の間に観測された 10 分間平均風速と最大瞬間風速の上位 10 位発現時に，その起因となった気象擾乱について調べた．その結果，両風速とも，10 位までのうち 9 件は台風通過時に観測されたものであった．次に，京都地方気象台における過去 43 年間の風速と降水量の年最大値を引き起こした気象擾乱について調べた．その結果，10 分間平均風速と最大瞬間風速は，いずれも 49%が台風通過時に発現していた．一方，年最大日降水量は 14%，年最大 1 時間降水量は 16%，年最大 10 分間降水量は 9%が台風通過時に記録されていた．これらの調査結果は，強風や大雨に対する防災対策が台風だけでなく温帯低気圧のような気象擾乱も対象としなければならないことを意味している．

Neocortical gap junction-coupled interneuron systems may induce chaotic behavior itinerant among quasi-attractors exhibiting transient synchrony

H. Fujii* and I. Tsuda

Neurocomputing 58-60 (2004), 151–157

Recent discovery of the massive presence of gap junction couplings among neocortical FS (and LTS) interneurons poses serious questions about their collective dynamical behavior, and their possible cognitive roles. We present here the theoretical possibility that a class of neurons coupled by gap junctions may emerge spatio-temporal chaos itinerant among attractors in Milnor’s sense, which in turn organizes synchronous cell groups transiently. Some physiological observations from the neocortex, e.g., local field potential (LFP) data exhibiting transient synchrony may provide evidence. We suggest also possible role in the so-called binding problem.

Itinerant Dynamics of Class I* Neurons Coupled by Gap Junctions

H. Fujii* and I. Tsuda

Computational Neuroscience: Cortical Dynamics, **Lecture Notes in Computer Science**, Vol. 3146, E'rdi, P., Esposito, A., Marinaro, M., Scarpetta, S. (Eds.) 2004, 140–160

Although it is generally recognized that "interneurons generate a variety of synchronous inhibitory rythms in the neocortex..." (J. R. Gibson et al.) and they "may play a key role in coordinating cortical activity..." (M. Galarreta & S. Hestrin), little is known how they behave in the *in vivo* neocortex. A salient property of some interneuron systems in the neocortex is that they are coupled by gap junctions (GJs)—a kind of electrical couplings very intensively between the same type of interneurons. In our previous studies, we reported the theoretical possibility that a class of neuron systems may exhibit spatio-temporal chaos when they are coupled by GJs, while the individual neurons, when isolated, exhibit only simple repetitive firings. This dynamics is emergent, and unveils only when cells are coupled by GJs. Mathematically, this phenomenon could be an expression of chaotic itinerancy among pseudo-attractors (or, *attractor ruins*). In view of the ubiquity of GJs—there at least five distinct interneuron systems coupled by GJs in the six layers of the neocortex, and in view of the significance of the concept of chaotic itinerancy in memory dynamics we give in this lecture a review about general property and collective dynamics of GJ-coupled neuronal systems.

(*) Computational Neuroscience: Cortical Dynamics, **Lecture Notes in Computer Science**, Vol. 3146, E'rdi, P., Esposito, A., Marinaro, M., Scarpetta, S. (Eds.) 2004 consist of revised lectures in the 8th International Summer School on Neural Nets, Erice, Italy, October 31–November 6, 2003.

Chaotic Itinerancy as a Mechanism of Irregular Changes between Synchronization and Desynchronization in a Neural Network

I. Tsuda, H. Fujii*, S. Tadokoro, T. Yasuoka, and Y. Yamaguti

J. Integrative Neuroscience 3 (2004), 159–182

We investigate the dynamic character of a network of electronically coupled cells consisting of class I point neurons, in terms of a finite dynamical system. We classify a subclass of class I point neurons, called class I* point neurons. Based on this classification, we use a reduced Hindmarsh-Rose (H-R) model, which consists of two dynamical variables, to construct a network model consisting of electronically coupled H-R neurons. Although biologically simple, the system is sufficient to extract the essence of the complex dynamics, which the system may yield under certain physiological conditions. The network model produces a transitory behavior as well as a periodic motion and spatio-temporal chaos. The transitory dynamics that the network model exhibits is shown numerically to be chaotic itinerancy. The transitions appear between various metachronal waves and all-synchronization states. The network model shows that this transitory dynamics can be viewed as a chaotic switch between synchronized and desynchronized states. Despite the use of spatially discrete point neurons as basic elements of the network, the overall dynamics exhibits scale-free activity including various scales of spatio-temporal patterns.

A Complex Systems Approach to an Interpretation of Dynamic Brain Activity I: ‘Chaotic itinerancy can provide a mathematical basis for information processing in cortical transitory and nonstationary dynamics

I. Tsuda and H. Fujii*

Computational Neuroscience: Cortical Dynamics, **Lecture Notes in Computer Science**, Vol. 3146, E’rdi, P., Esposito, A., Marinaro, M., Scarpetta, S. (Eds.) 2004, 109–128

The transitory activity of neuron assemblies has been observed in various areas of animal and human brain. We here highlight some typical transitory dynamics observed in laboratory experiments and provide a dynamical system’s interpretation of such behaviors. With the information theory of chaos, it is shown that a certain kind of chaos is capable of dynamically maintaining the input information rather than destroying it. Taking account of the fact that the brain works in noisy environment, the idea can be proposed that chaos exhibiting noise-induced order is appropriate for the representation of the dynamics concerned. The transitory dynamics typically observed in the brain seems to be allowed to appear in high-dimensional systems. New dynamical systems’ interpretation of the cortical dynamics is reviewed, cast in terms of high-dimensional transitory dynamics. This is a different interpretation from a conventional one, cast in terms of low-dimensional attractors. We focus our attention on, in particular, chaotic itinerancy, which is a dynamical concept describing a transitory dynamics among “exotic attractors”, or “attractor ruins”. We also emphasize the functional significance of chaotic itinerancy.

(*) Computational Neuroscience: Cortical Dynamics, **Lecture Notes in Computer Science**, Vol. 3146, E’rdi, P., Esposito, A., Marinaro, M., Scarpetta, S. (Eds.) 2004 consist of revised lectures in the 8th International Summer School on Neural Nets, Erice, Italy, October 31–November 6, 2003.

Functional Relevance of 'Excitatory' GABA Actions in Cortical Interneurons: A Dynamical Systems Approach

H. Fujii*, K. Aihara, and I. Tsuda

J. of Integrative Neuroscience 3 (2004), 183–205

The non-classical, but frequently reported behavior of GABAA receptor-mediated excitation in mature CNS has long been regarded as a puzzle. We theorize that the function of cortical GABAergic interneurons, which might constitute a subsystem of brain's GABA interneurons, is their ability of switching from inhibitory action to excitatory action depending on the level of spatio-temporal activity in progress. From the perspective of a dynamical systems approach, such "excitatory" GABAergic responses may serve to temporarily invoke attractor-like memories when extensively activated by, for example, top-down signals as category information or attention, while an ongoing background state of GABA changes its action to inhibition, returning the dynamical nature of the memory structure back to attractor ruins.

Prologue—The Work of the Late Professor Gen Matsumoto

K. Aihara, I. Tsuda, and H. Fujii*

J. Integrative Neuroscience 3 (2004), 111–113

Gen Matsumoto had pursued the reality of correspondence between *structure* and *function* in biological systems, based on the facts derived from experiments conducted by himself. His scientific interest was in the genesis of impulses in squid giant axons, the product of "biocomputers", and possible effects of 'love' on the brain, which were motivated by his own observation of remarkable recovery process in a brain-damaged patient. In all of his studies, he emphasized the biological significance of non-equilibrium systems. He insisted that a neuron can become functional only in far-from-equilibrium states. This means that a neuronal firing is generated by a dissipative structure [Nicolis77], [Kobatake70] of membranes. He also emphasized an importance of open systems as the most basic characteristic of dissipative systems, extending the range of energy to the range of information. Thus, his thinking extends to the idea that both humans and animals can receive and send information only provided things which set them at high motivational states are present. He considered 'love' to be the most important factor among such things.

サドル・ノード分岐型 I 類細胞のギャップ・ジャンクション結合系の時空カオス

中野　学・横山広通・藤井　宏

京都産業大学論集・自然科学系列第 32 号 (2003), 1–38

近年，大脳新皮質における抑制性介在細胞間，すなわち FS 細胞間，LTS 細胞間において，膨大なギャップ・ジャンクション (gap junction 以下，GJ と略記) と呼ばれる電気結合の存在が報告され，その脳の符号化・情報表現にはたしている機能的役割，GJ で結合された抑制系のシステム・レベルでの動力学について注目が集まっている．これらは皮質内でのスパイク・シンクロニーを制御する閾値下の機構という可能性があるが，理論的な研究はほとんど行われていない．

本論文ではこのような背景のもとで，脳の情報表現の研究への基礎作業として大脳新皮質における FS 細胞の GJ 結合系の動力学の検討を行った．ここでは，その中で得られたいくつかの新しい知見を第一報として報告したい．本研究で得られた主要な結果は，“ I 類細胞のサブクラス Ia の GJ 結合系は，一定の条件下で顕著な時空カオスを内包する ” と要約できる．一定の背景入力が存在すれば，たとえ背景入力に時間的・空間的ゆらぎが存在しなくとも，顕著な不規則時空パターンが内発的に生じる．また，Ia ニューロンは切り離された状態では，規則的なスパイク発火をする．その意味で，この時空カオスは結合系の示す創発的な動力学である． このようなニューロン系の GJ 結合系の動力学の研究自体，新しい領域であるが，さらにこのようなギャップ・ジャンクション結合系における創発的カオス動力学の存在の可能性という本研究の結果は数理的にも理論神経科学においても最初の報告である．

ここでの結果の理論神経科学への意義は，新皮質における “ GJ 結合抑制系は時空カオスを内包する ” という原理的可能性にある．このような原理的可能性自身，脳における情報の表現と符号化に関する研究に重大な意義をもつが，本論文では時空カオスの様相，パラメータ依存性，分岐構造などの数理的な側面に焦点を置いて報告する．

The Effective Size of Mixed Sexually and Asexually Reproducing Populations

Katsuei Yonezawa*, Takuro Ishii and Tsukasa Nagamine

Genetics Vol. 166: 1529–1539 (2004. 3)

Using the transition matrix of inbreeding and coancestry coefficients, the inbreeding (N_{eI}), variance (N_{eV}) and asymptotic ($N_{e\lambda}$) effective sizes of mixed sexual and asexual populations are formulated in terms of asexuality rate (δ), variance of asexual (C) and sexual (K) reproductive contributions of individuals, correlation between asexual and sexual contributions (ρ_{ck}), selfing rate (β) and census population size (N). The trajectory of N_{eI} toward $N_{e\lambda}$ changes crucially depending on δ, N and β, whereas that of N_{eV} is rather consistent. With increasing asexuality, $N_{e\lambda}$ either increases or decreases depending on C, K and ρ_{ck}. The parameter space in which a partially asexual population has a larger $N_{e\lambda}$ than a fully sexual population is delineated. This structure is destroyed when $N(1-\delta) < 1$, or $\delta > 1 - 1/N$. With such a high asexuality, tremendously many generations are required for the asymptotic size $N_{e\lambda}$ to be established, and $N_{e\lambda}$ is extremely large with any value of C, K and ρ_{ck} because the population is dominated eventually by individuals of the same genotype and the allelic diversity within the individuals decays quite slowly. In reality, the asymptotic state would occur only occasionally, and instantaneous rather

than asymptotic effective sizes should be practical when predicting evolutionary dynamics of highly asexual populations.

A comparison of restricted selection procedures to control genetic gains

Seiji Ieiri, Tetsuro Nomura*, Hiroyuki Hirooka and Masahiro Satoh

Journal of Animal Breeding and Genetics 121, 90–100 (2004)

Using Monte Carlo simulation, two schemes of restricted selection were compared under various combinations of genetic parameters and constraints on the genetic gains. The first selection scheme is the combination of best linear unbiased prediction (BLUP) evaluation and linear programming technique (BLUP+LP), and the second one is based on the restricted BLUP evaluation (RBLUP). It was generally shown that BLUP+LP selection should always be preferable to RBLUP selection, because of the smaller variation of genetic gains among replicates. The choice is especially important for the situation where the genetic parameters act as limiting factors for the achievement of intended genetic gains.

Monitoring of genetic diversity in the Japanese Black cattle population by the use of pedigree information

Takeshi Honda, Tetsuro Nomura*, Yuki Yamaguchi and Fumio Mukai

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Genetic diversity of the Japanese Black cattle population from 1960 to 2000 was monitored with estimates of effective numbers of ancestors. It was clarified that the genetic diversity had been drastically reduced during the last decade. The major cause of the reduction was considered to be the intensive use of a few sires with high breeding values of meat quality. Further examination using gene dropping simulation was conducted to obtain information on survival of founder alleles. Several founders showed low probabilities of allele extinction, irrespective of their relatively low genetic contributions. This suggests that these founders have lineages through which alleles are surely transmitted to the current breed. The use of these founders as a strategy for recovering the genetic diversity was discussed.

Reduction of inbreeding in commercial females by rotational mating with several sire lines

Takeshi Honda, Tetsuro Nomura* and Fumio Mukai

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A mating system to reduce the inbreeding of commercial females in the lower level was examined theoretically, assuming a hierarchical breed structure, in which favorable genes are accumulated in the upper level by artificial selection and the achieved genetic progress is transferred to the lower level through migration of males. The mating system examined was rotation mating with several closed sire lines in the upper level. Using the group coancestry theory, we derived recurrence equations for the inbreeding coefficient of the commercial females. Numerical computations showed that the critical factor for determining the inbreeding is the number of sire lines, and that the size each line has a marginal effect. If four or five sire lines were available, rotational mating was found to be quite an effective system to reduce the short- and long-term inbreeding of the commercial females.

Developments of prediction theories of the effective size of populations under selection

Tetsuro Nomura*

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The effective population size is a key parameter in the definition of selection programs, because the magnitude of this parameter determines both the rate of inbreeding and the amount of genetic drift in the population. Prediction of the effective size of selected populations is complicated by the fact that selection has a cumulative effect on the effective size. In this article, two basic approaches to predict the effective size of populations under selection were summarized, and the interrelation among them was clarified. Several extensions to practical situations relevant to animal breeding, such as non-random mating, index selection and marker-assisted selection, were also reviewed.

Methods for minimizing the loss of genetic diversity in conserved populations with overlapping generations

Tetsuro Nomura*

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Minimization of the average coancestry in a population has been theoretically proven to be the most efficient method to preserve genetic diversity. In the present study, based on a population genetic model, two methods to minimize the average coancestry in populations with overlapping generations were developed. For a given parental coancestry structure, the first method (OG) minimizes the average coancestry in the next generation, and the second method (LT) is designed to minimize the long-term accumulation of coancestry. The efficiencies of the two methods were examined by stochastic simulation. Compared to random choice of parents, the annual effective population sizes under the two proposed methods increased 2–3 folds. The difference among the two methods was small in a population with short generation interval. For populations with long generation intervals, the OG method showed a slightly larger annual effective size in an initial few years. However, in the subsequent years, the LT method gave a 5-15% larger annual effective size than the OG method. From these results, it is suggested that the LT method would be preferred to the OG method in most practical situations.