Mathematisches Forschungsinstitut Oberwolfach

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Stochastics in the Sciences

March 11th–March 17th 2001

The meeting was organized by Anton Bovier (Berlin), Richard D. Gill (Utrecht), and Willem R. van Zwet (Leiden). Forty-four participants took part, and 26 lectures were given during the well-attended morning and afternoon sessions. An additional evening lecture was presented by Richard Gill.

The goal of the meeting was to bring together researchers working on different aspects of "stochastics in the sciences". These aspects include the modelling of processes in nature as random processes, their statistics as well as the analysis of the resulting stochastic models. Topics of the lectures included interacting particle systems, spin systems as well as diffusions. Systems in equilibrium were considered as well as the dynamics of systems out of equilibrium, and problems of phase transitions and metastability were discussed. One series of talks was devoted to statistical problems in geophysics, astronomy and high-energy physics while another one addressed quantum systems. The abstracts of the talks are given below (in chronological order).

The excellent working conditions and the inspiring atmosphere made the meeting a great success and it's a pleasure to thank the cheerful staff for making our stay so enjoyable.

Abstracts

Phase transitions for interacting diffusions

Frank den Hollander
(joint work with Andreas Greven (Erlangen))

In this talk we consider the following system of coupled stochastic differential equations:

$$dX_i(t) = \sum_{j\in\mathbb{Z}^d} a(i,j)[X_j(t) - X_i(t)]\,dt + \sqrt{b(X_i(t))}\,dW_i(t) \qquad (i \in \mathbb{Z}^d,\, t \geq 0).$$

Here, the components take values in $[0,\infty)$, $a(\cdot,\cdot)$ is an irreducible random walk transition kernel on $\mathbb{Z}^d\times\mathbb{Z}^d$, $b(\cdot)$ is a locally Lipschitz continuous function on $[0,\infty)$ satisfying $b(0) = 0$, $b(x) > 0$ for $x > 0$ and $b(x) = O(x^2)$ as $x \to \infty$, while $\{(W_i(t))_{t\geq 0} : i \in \mathbb{Z}^d\}$ is a collection of independent standard Brownian motions. As initial configuration we take

$$X_i(0) = \theta \quad \forall i \in \mathbb{Z}^d \qquad \text{for some } \theta \in (0,\infty).$$

As $t \to \infty$ the system either converges to a non-trivial equilibrium or it dies out locally (i.e., converges weakly to the all-0 configuration). We are interested in classifying this behavior. The answer is different in the following two classes.

I. $b(x) = o(x^2)$ as $x \to \infty$.

The system converges to a non-trivial equilibrium if and only if $\hat{a}(\cdot,\cdot)$ is transient, where $\hat{a}(i,j) = \frac{1}{2}[a(i,j) + a(j,i)]$. This dichotomy holds irrespective of the precise form of $b(\cdot)$.

II. $b(x) = bx^2$, $b > 0$.

Suppose that $a(i,j) = a(j,i)$.

1. If $a(\cdot,\cdot)$ is recurrent, then the system dies out locally for any $b > 0$.
2. If $a(\cdot,\cdot)$ is transient, then there exists a sequence

$$b_* > b_2 > b_3 > b_4 > \ldots \downarrow 0$$

such that

i. the system converges to a non-trivial equilibrium if and only if $b < b_*$;
ii. this equilibrium has a finite m-th moment if and only if $b < b_m$ $(m \geq 2)$.

Moreover, $b_m \asymp 1/m$ as $m \to \infty$.

Modelling marine magnetic anomaly lineations by an Ornstein–Uhlenbeck process

Ted Chang

The so called marine magnetic anomaly lineations provide the best information to reconstruct the past position of tectonic plates. In estimating these reconstructions, the shapes of the lineations become a nuisance parameter and hence a parsimonious model for their shapes becomes necessary. Previous models assumed a piecewise great circular shape, however, as the data density has increased, these models become untenable. We propose to use an Ornstein–Uhlenbeck process to model these shapes.

The talk will start with a general discussion of the source of the marine magnetic anomaly lineations and their role in tectonic plate reconstructions. We will then discuss some of the mathematics of how we will estimate a reconstruction under an Ornstein–Uhlenbeck process model for the shape of the lineations. Finally, we will discuss the results of such models using a series of data sets from the Central Atlantic.

No geophysical background will be needed.

Fluctuations of the free energy in Gaussian spin glass models: the REM and the p-spin SK model

Irina Kourkova

(joint work with Anton Bovier and Matthias Löwe)

We prove the Central Limit Theorem for the free energy in the p-spin version of the Sherrington–Kirkpatrick Spin Glass model on a scale $N^{-(p-2)/4}$. This is shown to hold for all values of the inverse temperature β smaller than a critical β_p, and $\beta_p \to \sqrt{2\ln 2}$ as $p \uparrow +\infty$. We also establish precise limit theorems for the free energy and the partition function of the Random Energy Model at *all* temperatures. For $\beta < \sqrt{2\ln 2}$, fluctuations of the free energy are found at an *exponentially small* scale: For β up to a new critical value $\sqrt{\ln 2/2}$ the rescaled fluctuations are Gaussian, while below they are driven by the Poisson process of the extreme values of the random energies. For $\beta > \sqrt{2\ln 2}$, the fluctuations of the logarithm of the partition function are on scale one and are expressed in terms of the Poisson process of extremes. For $\beta = \sqrt{2\ln 2}$ the partition function divided by its expectation converges to 1/2.

Survey on long-time tails for the parabolic Anderson model

Wolfgang König

We consider the *heat equation with random potential*,

$$\partial_t u(t,x) = \tfrac{1}{2}\Delta u(t,x) + \xi(x)u(t,x)$$

on $(0,\infty)\times\mathbb{S}$ (where $\mathbb{S}=\mathbb{Z}^d$ or $\mathbb{S}=\mathbb{R}^d$) with localized initial condition $u(0,x)=\delta_0(x)$. Here Δ is the (discrete or continuous, respectively) Laplace operator, and $\xi = (\xi(x))_{x\in\mathbb{S}}$ is a random potential (i.i.d. in the discrete case, shift-invariant in the continuous case). This is a model for random mass transport through a random medium having sources (space points x with $\xi(x)>0$) and sinks (space points x with negative $\xi(x)$). Starting with one particle of unit mass at the origin at time 0, $u(t,x)$ is the expected mass at the point x at time t, for a fixed realization of the random potential ξ.

We are interested in the long-time behavior of the random field $u(t,\cdot)$ (almost surely and the moments), for various important classes of potentials ξ. Of particular interest is the phenomenon of *intermittency*: $u(t,\cdot)$ develops high peaks on small islands which give the main contribution to the total mass in $\mathbb{S}$.

In the talk, I presented a survey of the existing mathematically rigorous work on this problem, explained heuristics and indicated some proofs.

Some applications of directional statistics to astronomy

P. E. Jup

(joint work with J. Cuypers, P. Kim, J-Y Koo, P. Wiegert)

In many astronomical problems the data are directions (represented by unit vectors). The application of directional statistics to astronomy was illustrated by three such problems, involving comets, binary stars, and asteroids, respectively.

Non-parametric density estimation of normals to the orbits of long-period comets showed uniformity of both ecliptic longitude and (surprisingly) ecliptic latitude. Analyses of (i) orbital planes of visual binary stars, (ii) spin axes of asteroids are complicated by (a) mirror-image ambiguities, (b) geometrical selection effects. For both binary stars and asteroids, score tests within simple parametric models indicated underlying uniformity subject to considerable selection.

Quantum measurement, quantum statistical inference, and nonlocality without entanglement

Richard Gill

I motivate my talk by recent work of Dutch experimenters on creating a quantum superposition of macroscopically distinct states, the so-called Delft Qubit, or Schrödinger SQUID. Next I discuss the basic ingredients of quantum measurement theory: (pure) states, (unitary) evolutions, entanglement, and (simple) measurements. The use of the basic building blocks is illustrated by quantum teleportation of one qubit using an entangled pair of qubits. I next explain how combining the four building blocks in arbitrary ways leads one to the class of Operator-valued Probability Measures (OProM's) as the class of all possible maps from a (possible mixed) initial quantum state to a probability law of the outcome of a measurement on some outcome space (theorems of Naimark, Holevo, Ozawa). We are now able to formulate and solve problems of optimal statistical inference concerning an unknown quantum state, where in the optimization one may optimize over measurement (experimental setting) as well as over the statistical inference. I survey recent work of Gill and Massar (Phys Rev A 29 (2000), 2312–2327) where in particular the problem of optimal estimation of an unknown qubit based on N identical copies is considered. If the state is known to be pure, it turns out that an optimal measurement procedure is obtained by a sequence of separate, adaptive, simple measurements on separate qubits (adaptive means: the setting of the n'th measurement may depend on the outcome of the preceding ones). If the state is mixed, the situation changes dramatically. We know what is the best that can be done by separable (nonentangled) measurements, and know that it can be achieved by a similar strategy as was optimal for the pure case. However if one allows non-separable measurements, a dramatic increase in efficiency is possible. It is an open problem to determine exactly how much improvement is possible (we have upper and lower bounds, with a large gap between). This phenomenon is related to that of nonlocality without entanglement recently discovered by Bennet et al in the context of quantum information theory.

Tomographic methods for universal quantum estimatio

Mauro D'Ariano

"Quantum Tomography" is a general method for estimating arbitrary ensemble averages —including the density matrix itself—of any quantum system, through the measurement of a "quorum" of observables. Recently the method has been extended to the estimation of the matrix form of any "quantum operation" (i.e. quantum evolutions and measurements), using only a fixed "entangled state" as the input state, the entangled state playing the role of all possible input states in "quantum parallel". In the talk at Oberwolfach the general theory has been presented in a simple framework of spanning sets for linear spaces of operators, with attention devoted to the infinite-dimensional case. A rich list of examples of applications for different quantum systems has been given, with particular focus on quantum optics. Some results from experiments in quantum optics has been reviewed. Finally, the very recent "Quantum Holography" method has been presented, where a complete knowledge of a quantum system can be achieved by measuring a single "universal observable" on an extended Hilbert space.

Selfdecomposability in the physical sciences and in finance

Ole E. Barndorff-Nielsen

After a brief review of the definition and properties of selfdecomposable probability laws and of OU processes (i.e. stationary processes of Ornstein–Uhlenbeck type), the applicability of these concepts to modelling in finance and turbulence was discussed, with the main emphasis on stochastic volatility modelling of stock prices and exchange rates. The second part of the talk first described the concept of freeness, or free independence, and the associated free infinite divisibility, and then a definition of free selfdecomposability was proposed and shown to possess properties closely analogous to those of 'classical' selfdecomposability. In particular, integration with respect to free Lévy processes was introduced and it was shown that any freely selfdecomposable observable can be represented in law as the integral of the exponential function with respect to an associated Lévy process. To a large extent the talk was based on joint work with respectively Neil Shephard and Steen Thorbjørnsen.

Spectral theory and metastability for Markov chains

Markus Klein

(joint work with Anton Bovier, Michael Eckhoff and Véronique Gayrard)

For a large class of Markov chains with discrete state space and transition matrix P_N we study the relation between the low-lying spectrum of the discrete generator $1 - P_N$ and the metastable behaviour of the chain. We define the notion of a *metastable set* as a subset of the state space Γ_N such that (i) this set is reached from any point $x \in \Gamma_N$ without return to x with probability at least b_N, while (ii) for any two point x, y in the metastable set, the probability $T_{x,y}^{-1}$ to reach y from x without return to x is smaller than $a_N^{-1} \ll b_N$; finally, the invariant mass of each of the metastable points is required not to be too small. Under an additional non-degeneracy assumption, we show that in such a situation:

(i) To each metastable point corresponds a metastable state, whose mean exit time can be computed precisely.

(ii) To each metastable point corresponds one simple eigenvalue of $1 - P_N$ which is essentially equal to the inverse mean exit time from this state.

Moreover, these results imply very sharp uniform control of the deviation of the probability distribution of metastable exit times from the exponential distribution.

The error estimates are best in the case of reversible chains. Using symmetrization of a non-reversible chain with respect to the quadratic form induced by its invariant measure one obtains somewhat weaker estimates for non-reversible chains as well.

Our methods use a combination of potential and spectral theory with probability theory.

Statistical inverse problems in high energy physics

Zbigniew Szkutnik

Motivated by high energy physics unfolding problems, we presented some results on approximation effects in unfolding intensity function of an indirectly observed, nonhomogeneous Poisson process. The setup differs from the standard one in that the exact form of the folding operator may not be known for finite samples (the knowledge of the operator becomes complete only asymptotically). Strong L^2-consistency of quasi-maximum likelihood B-spline sieve estimators was discussed and risk convergence rates were given. The degree of ill-posedness of the problem, as measured by the decay rate of the singular values of the (discrete) folding operator, requires a certain order of the B-splines used and a certain degree of smoothness of the estimated function. Special modifications of the standard discrete approximation to the folding operator and a special form of the parametric sets have been proposed, which help to keep the smoothness assumptions reasonably weak.

Renormalizations of particle systems in equilibrium

Iljana Zähle

We are interested in the fluctuation behavior of particle systems in equilibrium. On the one side we study the voter model on the d-dimensional integer lattice ($d \geq 3$), which belongs to the category of spin systems, on the other side we study the d-dimensional branching random walk ($d \geq 3$), which represents the branching systems. Both processes have extremal equilibria for every intensity. We show that the fluctuations of space and space–time averages with non-classical scaling are Gaussian in the limit. For this purpose we use the historical process, which allows a family decomposition. To control the distribution of the families we use the concept of duality in case of the voter model respectively the concept of canonical measures and Palm distributions in case of the branching random walk.

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Extreme value behavior in the Hopfield model

David M. Mason

(joint work with Anton Bovier)

We study a Hopfield model whose number of patterns M grows to infinity with the system size N, in such a way that $M(N)^2 \log M(N)/N$ tends to zero. In this model the unbiased Gibbs state in volume N can essentially be decomposed into $M(N)$ pairs of disjoint measures. We investigate the distributions of the corresponding weights, and show, in particular, that these weights concentrate for any given N very closely to one of the pairs, with probability tending to one. Our analysis is based upon a new result on the asymptotic distribution of order statistics of certain correlated exchangeable random variables.

Hydrodynamic limits and curvature flows

Gérard Ben Arous
(joint work with Ofer Zeitouni)

We present two new systems of particles which approach, in the hydrodynamic limit, the mean curvature flow and the affine curvature flow for curves in the plane. These systems are essentially zero-range processes with birth and death, on the circle. The basic trick is to transform by the Gauss map the curvature flows in nonlinear evolutions of measures on the circle which can be approximated by particle systems.

Space–time modeling of earthquake occurrences

Yosihiko Ogata

Based on several established empirical laws in the traditional studies of aftershock statistics, we constructed a space–time point-process model in terms of the conditional intensity function, which includes seven parameters to characterize seismicity in a geophysical region. We further considered a hierarchical extension of the model such that each parameter is a function of location, which is represented by a 2D piecewise linear function consisting of facets defined on Delaunay tessellated triangles whose vertices are locations of earthquakes in the data. Then, an objective Bayesian method is implemented for the optimal maximum a posteriori estimates showing the characteristics of seismicity in and around Japan. Our final goal was to detect space–time volumes in which 'relative' seismic quiescence have taken place, for the investigation of the causal relationship to the forthcoming great earthquakes. For this purpose we used a space–time piecewise linear function defined on Delaunay tessellated tetrahedra whose vertices are locations and times of earthquakes in the data, to get the 3D image of the 'residual' of the previously estimated space–time conditional intensity rates.

Moderate deviations for longest increasing subsequences in random permutations

Franz Merkl

The distribution of the lengths of longest increasing subsequences in random permutations has attracted much attention especially in the last five years. In 1999, Baik, Deift, and Johansson determined the (nonstandard) central limit behaviour of these random lengths. They use deep methods from complex analysis and integrable systems, especially non-commutative Riemann Hilbert theory. The large deviation behaviour of the same random variables was determined before by Seppäläinen, Deuschel, and Zeitouni, using more classical large deviation techniques. In the talk, some recent results on the moderate deviations of the length of longest increasing subsequences are presented. This concerns the domain between the central limit regime and the large deviation regime. The proof is based on a Gaussian saddle point approximation around the stationary points of the transition function matrix elements of a certain noncommutative Riemann Hilbert problem of rank 2. The results grew out of joint work with Matthias Löwe and Silke Rolles.

Quantum interacting particles

LUIGI ACCARDI

Quantum probability is a natural development of classical probability theory, which has been developed in the past 25 years. A quantum probability space is equivalent to uncountably many classical probability spaces (Gleason's theorem) and therefore any result in quantum probability (QP) corresponds to infinitely many results in classical probability (law of large numbers, central limit theorems, large deviations, ...)

In physics some classical stochastic processes are naturally associated to important quantum phenomena. For example: branching processes to neutron diffusion, birth and death processes to laser theory, ... This fact raises the following question: How is it possible that typically quantum phenomena are well described by classical stochastic processes? The answer to this question came from the stochastic limit of quantum theory (SLQT). The SLQT describes the long time cumulation of weak interaction effects. Its main result is the "stochastic golden rule" (a generalization of Fermi golden rule) which allows, given a standard Hamiltonian system, to associate to it a quantum Langevin equation driven by some quantum white noise. This quantum white noise describes the fast degrees of freedom of the original Hamiltonian system.

The SLQT also shows that this Langevin equation naturally describes a classical stochastic process, obtained by restriction of the quantum flow to the abelian sub-algebra, generated by the spectral projections of the slow degrees of freedom of the system. In the Open System Scheme (OSS) the slow degrees of freedom are called the System (S) and the fast ones, the Reservoir (R).

If the system is a (generalized) quantum Ising model, the classical process obtained by restriction to the spectral projections of the system Hamiltonian, is described by a generalization of the Glauber dynamics.

A great variety of classical interacting particle systems is obtained in this way and their behavior (ergodicity, mass gap, ...) in some sense "drives" the behavior of the larger quantum system.

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Macroscopic quantum state superposition and quantum cloning: A new multiparticle test of Bell nonlocality in quantum mechanics

FRANCESCO DE MARTINI

We report the realization of a Universal Optimum Quantum Cloning Machine and of an "all optical" Schrödinger-Cat apparatus based on quantum injected-entangled Optical Parametric Amplification. The System has been adopted for "amplifying" and "cloning" inputs "qubits" and "E-bits", i.e. entangled photon states. The theory of a multiparticle Bell-inequality test to be performed by the present apparatus is presented.

The new process of "quantum injection" into a femtosecond laser excited optical parametric amplifier (QIOPA) operating in entangled configuration is adopted to "amplify" the quantum entanglement and superposition properties of the photon couples generated by parametric down-conversion. Precisely, in the domain of Quantum Information the QIOPA device is adopted to "amplify" in a larger dimensionality Hilbert state the single photon states ("qubits") and the "2 photon states" ("e-bits"). Investigation of the invariance properties of the OPA interaction Hamiltonian shows that, under appropriate dynamical conditions, the device may act as a Universal Quantum Cloning Machine (UQCM) of the input qubits (1, 2). We report the first experimental realization of such a device with cloning of $M = 3$ qubits out of an input $N = 1$ qubit. The structure of the Wigner function and of the field's correlation functions show a multiphoton Schrödinger-Cat behaviour of the emitted field which is largely detectable against the squeezed vacuum noise. The realization and a relevant fundamental application of the first "all optical" multiphoton Schrödinger-Cat are reported. The technical and epistemological perspectives of the new methods are considered in the light of the general Schrödinger-Cat Paradigm with relation to the ontological status of the "physical reality" (3, 4).

The QIOPA device was also adopted to "amplify" couples of photons in entangled linear-polarization states into an entangled multiphoton states. In this respect the theory of a multiparticle Bell-type inequality test to be performed soon by the present apparatus is presented (5, 6).

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Phase transitions and Bose condensation in mean field and Lebowitz–Penrose limits

Errico Presutti

The talk is about some research I am doing directed at understanding the role of quantum effects on phase transitions. Quantum effects may be dominant as for instance in the Bose condensation, which is in various ways related to superfluidity and superconductivity. On the other hand, quantum effects are minor at higher temperatures, as for instance in the liquid–vapour phase transitions. In this talk I will report on some works in progress which prove a liquid–vapour phase transition for a class of quantum models. I will then discuss Bose condensation for mean field models, relating the appearance of the condensed phase to the presence of "long loops" in the Feynmann–Kac representation. I will then briefly discuss the problems which appear when we relax the mean field assumption and consider Kac potentials.

Metastability for the Ising model with a parallel dynamics

Francesca R. Nardi
(joint work with Emilio N.M. Cirillo)

We consider the problem of metastability for the Ising model with a parallel updating rule. A parallel version of the heat bath dynamics is considered: the resulting dynamics is a reversible Probabilistic Cellular Automaton. We prove that the phenomenology of metastability is changed in the sense that an intermediate chessboard phase appears during the excursion from the minus metastable phase towards the plus stable phase. Nevertheless the typical lifetime of the metastable phase is the same as in the serial case.

Stochastic resonance in a double-well potentia

Barbara Gentz
(joint work with Nils Berglund, ETH Zürich)

We consider the overdamped motion of a particle in a double-well potential. This particle is subject to two different kinds of perturbation: Deterministic *periodic driving* and *additive white noise.* The amplitude of the driving is assumed to be too small to allow for transitions between the potential wells in the absence of noise. Without periodic forcing, the noise would cause transitions from one potential well to the other at random times. When both perturbations are combined, however, and their amplitudes suitably tuned, the particle will flip back and forth between the wells in a close to periodic way.

There exists a threshold value for the noise intensity such that below threshold, sample paths are concentrated near one potential well, and have an exponentially small probability to jump to the other well, while above threshold, transitions occur with probability exponentially close to 1. The power-law dependence of the critical noise intensity on frequency and amplitude of the driving is derived. The transition zones are localised in time near instants of maximal forcing, their width being determined by the noise intensity.

Random Schrödinger operators

Hajo Leschke

A brief introduction to the theory of Schrödinger operators with a random potential, which act on the Hilbert space $L^2(\mathbb{R}^d)$, is followed by a survey of recent works for Gaussian and Poissonian random potentials. In the Gaussian case results on absolute continuity of the integrated density of states N and on spectral (Anderson) localization are included. In the Poissonian case for $d = 2$ with repulsive impurities and a perpendicular constant magnetic field it is pointed out that the leading asymptotic low-energy behaviour of N (the so-called Lifshits tail) changes from quantum to classical, if the long-distance decay of the underlying single-impurity potential changes from super-Gaussian to (regular) sub-Gaussian.

Local limit analysis of pair-correlation functions for the Ising-type models on $\mathbb{Z}^d$

Dmitri Ioffe

Two point functions of finite range ferromagnetic models with pair interactions obey the Ornstein–Zernike asymptotic formula in any dimension $d \geq 2$ and at every sub-critical value of the inverse temperature $\beta < \beta_c$.

Quantum causality, nondemolition principle, and prediction in quantum sciences

Vjacheslav P. Belavkin

The development of quantum measurement theory, initiated by von Neumann, indicated a possibility to resolve the interpretational crisis of quantum mechanics by divorcing the algebras of the dynamical generators and observables. It is shown that within this approach quantum causality can be rehabilitated in the form of superposition rule of compatibility of actual observables with the potential future. This rule together with the self-compatibility of measurements insuring the consistency of histories is called the nondemolition principle. The application of this rule in the form of the dynamical commutation relations leads to the derivation of the von Neumann projection postulate, and also to the more general reductions, instantaneous, spontaneous, and even continuous in time. This gives a quantum probabilistic solution, in the form of the dynamical filtering equations, of the notorious measurement problem which was tackled unsuccessfully by many famous physicists starting from Schrödinger and Bohr. The simplest Markov quantum stochastic process for the time continuous measurement involves a boundary value problem for input waves in one extra dimension.

Absence of continuous symmetry breaking in two-dimensional lattice systems

Yvan Velenik

(joint work with Dima Ioffe and Senya Shlosman)

Let G be a compact connected Lie group. A classical result of Statistical Physics is that all Gibbs states of a two-dimensional lattice system with G-invariant interaction are G-invariant, provided the interaction is twice continuously differentiable and decays fast enough.

I'll explain how the smoothness assumption can be relaxed to simply continuity.

Perfect simulation for long-memory processes

Francis Comets

In this joint work with R. Fernandez and P. Ferrari, we present a perfect simulation algorithm for stationary processes indexed by $\mathbb{Z}$, with summable memory decay. Depending on the decay, we construct the process on finite or semi-infinite intervals, explicitly from an i.i.d. uniform sequence. Even though the process has infinite memory, its value at time 0 depends only on a finite, but random, number of these uniform variables. The algorithm is based on a recent regenerative construction of these measures. As applications, we discuss the perfect simulation of binary autoregressions.

A Poisson model for sequence alignments

Anton Wakolbinger

(joint work with Dirk Metzler and Steffen Grossmann)

Aligning two (DNA or amino acid) sequences means pairing those sites of the two sequences which are supposed to have evolved from a common ancestral site. A *local* alignment (which consists of subintervals of the two sequences) is scored by rewarding matches of paired letters, and penalizing mismatches as well as gaps. Only recently, D. Siegmund and B. Yakir (Ann. Statist. 2000) derived, in the limit of an increasing gap open penalty, the asymptotic distribution of high scores under a null model of independent sequences.

Inspired by the Poisson approximation of Dembo, Karlin and Zeitouni (Ann. Probab. 1994) for good gapless alignments, we propose a Poisson model which explains central features of the Siegmund–Yakir asymptotics, and gives a reasonable idea of the geometry of good gapped local alignments in (and probably also beyond) the SY-regime.

Reported by Barbara Gentz.

Participants

Prof. Dr. Luigi Accardi
accardi@volterra.mat.uniroma2.it
Centro Vito Volterra
Universita degli Studi di Roma II
Tor Vergata
Via della Ricerca Scientifica
I-00133 Roma

Prof. Dr. Michael Baake
michael.baake@uni-tuebingen.de
Fachrichtung Mathematik/Informatik
Universität Greifswald
Friedrich-Ludwig-Jahn-Str. 15a
17489 Greifswald

Prof. Dr. Ole E. Barndorff-Nielsen
oebn@imf.au.dk
MaPhySto
Dept. Mathematical Sciences
Aarhus University
Ny Munkegade
DK-8000 Aarhus C

Prof. Dr. Vjacheslav P. Belavkin
vpb@maths.nott.ac.uk
Department of Mathematics
The University of Nottingham
University Park
GB-Nottingham , NG7 2RD

Prof. Dr. Gerard Ben Arous
Gerard.Benarous@epfl.ch,
anabela.querino@epfl.ch,
benarous@masg57.epfl.ch
Departement de Mathematiques
Ecole Polytechnique Federale
de Lausanne
CH-1015 Lausanne

Prof. Dr. Nils Berglund
berglund@math.ethz.ch
Mathematik Departement
ETH Zürich
ETH-Zentrum
Rämistr. 101
CH-8092 Zürich

Dr. Anton Bovier
bovier@wias-berlin.de
Weierstraß-Institut für
Angewandte Analysis und Stochastik
im Forschungsverbund Berlin e.V.
Mohrenstr. 39
10117 Berlin

Prof. Dr. Ted C. Chang
tcc8v@pitman.stat.virginia.edu
Department of Statistics
University of Virginia
Cabell Drive
Halsey Hall
Charlottesville , VA 22903
USA

Prof. Dr. Francis M. Comets
comets@math.jussieu.fr
U. F. R. de Mathematiques
Case 7012
Universite de Paris VII
2, Place Jussieu
F-75251 Paris Cedex 05

Prof. Dr. Giacomo Mauro D'Ariano
dariano@pv.infn.it
Dipt. di Fisica "A.Volta"
Universita degli Studi di Pavia
Via Bassi 6
I-27100 Pavia

Prof. Dr. Francesco De Martini
Dipartimento di Fisica
Universita degli Studi di Roma I
"La Sapienza"
Piazzale Aldo Moro, 2
I-00185 Roma

Prof. Dr. Jean Dominique Deuschel
deuschel@math.tu-berlin.de
Fachbereich Mathematik
Technische Universität Berlin
Straße des 17. Juni 136
10623 Berlin

Dr. Michael Eckhoff
eckhoff@amath.unizh.ch
Institut für Mathematik
Universität Zürich
Winterthurerstr. 190
CH-8057 Zürich

Dr. Klaus Fleischmann
fleischmann@wias-berlin.de
Weierstraß-Institut für
Angewandte Analysis und Stochastik
im Forschungsverbund Berlin e.V.
Mohrenstr. 39
10117 Berlin

Dr. Nina Gantert
N.gantert@math.uni-karlsruhe.de
Inst. für Mathematische Stochastik
Universität Karlsruhe
Englerstr. 2
76128 Karlsruhe

Prof. Dr. Veronique Gayrard
veronique.gayrard@epfl.ch
Departement de Mathematiques
Ecole Polytechnique Federale
de Lausanne
CH-1015 Lausanne

Dr. Barbara Gentz
gentz@wias-berlin.de
Weierstraß-Institut für
Angewandte Analysis und Stochastik
im Forschungsverbund Berlin e.V.
Mohrenstr. 39
10117 Berlin

Prof. Dr. Hans-Otto Georgii
georgii@rz.mathematik.uni-
muenchen.de
Mathematisches Institut
Universität München
Theresienstr. 39
80333 München

Prof. Dr. Richard D. Gill
gill@math.ruu.nl
Mathematisch Instituut
Universiteit Utrecht
P. O. Box 80.010
NL-3508 TA Utrecht

Prof. Dr. Friedrich Götze
goetze@mathematik.uni-bielefeld.de
Fakultät für Mathematik
Universität Bielefeld
Postfach 100131
33501 Bielefeld

Prof. Dr. Frank den Hollander
hollander@eurandom.tue.nl
EURANDOM
P.O.Box 513
NL-5600 MB Eindoven

Prof. Dr. Dmitri Ioffe
ieioffe@ie.technion.ac.il
Faculty of Industrial Engineering
Technion
Haifa 32000
ISRAEL

Prof. Dr. Peter E. Jupp
pej@st-andrews.ac.uk
School of Mathematics and Stochastics
University of. St. Andrews
North Haugh
St. Andrews KY16 9SS
SCOTLAND

Lars Kauffmann
kauffman@math.uni-frankfurt.de
Fachbereich Mathematik
Universität Frankfurt
60054 Frankfurt

Prof. Dr. Werner Kirsch
werner.kirsch@mathphys.ruhr-uni-bochum.de
Institut f. Mathematik
Ruhr-Universität Bochum
Gebäude NA
44780 Bochum

Prof. Dr. Markus Klein
mklein@math.uni-potsdam.de
Institut für Mathematik
Universität Potsdam
Postfach 601553
14415 Potsdam

Dr. Achim Klenke
klenke@mi.uni-erlangen.de
Mathematisches Institut
Universität Erlangen
Bismarckstr. 1 1/2
91054 Erlangen

Dr. Wolfgang König
koenig@math.tu-berlin.de
Fachbereich Mathematik / FB 3
Sekr. MA 7-5
Technische Universität Berlin
Straße des 17. Juni 136
10623 Berlin

Prof. Dr. Irina Kourkova
kourkova@ccr.jussieu.fr
Laboratoire de Probabilites
Universite Paris 6
tour 56
4 place Jussieu
F-75252 Paris Cedex 05

Prof. Dr. Hajo Leschke
leschke@theorie1.physik.uni-erlangen.de
Institut für Theoretische Physik
Universität Erlangen-Nürnberg
Staudtstraße 7
91058 Erlangen

Dr. Matthias Löwe
loewe@sci.kun.nl
Subfaculteit Wiskunde
Katholieke Universiteti Nijmegen
Postbus 9010
NL-6500 GL Nijmegen

Prof. Dr. David M. Mason
davidm@math.udel.edu
Department of Mathematical Sciences
University of Delaware
501 Ewing Hall
Newark , DE 19716-2553
USA

Franz Merkl
merkl@eurandom.tue.nl
EURANDOM
Technical University Eindhoven,R.C.
P.O. Box 513
NL-5600 MB Eindhoven

Peter Mörters
peter@mathematik.uni-kl.de
Fachbereich Mathematik
Universität Kaiserslautern
Erwin-Schrödinger-Straße
67663 Kaiserslautern

Prof. Dr. Francesca Nardi
nardi@eurandom.tue.nl
EURANDOM
Technical University Eindhoven,R.C.
P.O. Box 513
NL-5600 MB Eindhoven

Prof. Dr. Yosihiko Ogata
ogata@ism.ac.jp
Institute of Statistical
Mathematics
4-6-7 Minami Azabu, Minato-ku
Tokyo 106
JAPAN

Prof. Dr. Enrico Presutti
presutti@mat.uniroma2.it
Dipartimento di Matematica
Universita degli Studi di Roma II
Tor Vergata
Via Orazio Raimondo
I-00173 Roma

Prof. Dr. Zbigniew Szkutnik
szkutnik@mat.agh.edu.pl
Department of Applied Mathematics
University of Mining and Metallurgy
Al. Mickiewicza 30
30-059 Krakow
POLAND

Dr. Yvan Velenik
velenik@cmi.univ-mrs.fr
LATP-UMT CNRS 6632
Centre de Math. et Informatiques
Universite de Provence
39, rue F. Joliot-Curie
F-13453 Marseille Cedex 13

Prof. Dr. Anton Wakolbinger
wakolbin@math.uni-frankfurt.de
Fachbereich Mathematik
Universität Frankfurt
Postfach 111932
60054 Frankfurt

Dr. Matthias Weber
matthias.weber@math.tu-dresden.de
Institut für Mathematische
Stochastik
Technische Universität Dresden
01062 Dresden

Iljana Zähle
zaehle@mi.uni-erlangen.de
Mathematisches Institut
Universität Erlangen
Bismarckstr. 1 1/2
91054 Erlangen

Prof. Dr. Milos Zahradnik
mzahrad@karlin.mff.cuni.cz
Dept. of Mathematical Analysis
Charles University
Sokolovska 83
18600 Praha 8
CZECH REPUBLIC

Prof. Dr. Willem R. van Zwet
vanzwet@math.leidenuniv.nl
Mathematisch Instituut
Rijksuniversiteit Leiden
Postbus 9512
NL-2300 RA Leiden