Long time behaviour of self-blocking immigration

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Abstract.
We consider systems of independent Markov chains. At one particular site new particles try to enter at constant rate but are only allowed to do so if this "source" is not occupied by another (older) particle. Our questions focus on the behaviour starting from the empty configuration. While the total number of particles obviously always grows without bound, this need not imply local explosion: We show that the number of particles in a finite "box" remains stochastically bounded (and hence the system converges to some equlibrium) iff the motion of individual particles is transient. We also present some results and conjectures concerning the growth rate for recurrent motion.

Some new results for the stepping stone model

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Abstract.
We consider the stepping stone model on the torus of size L in the two-dimensional integer lattice, with a colony of size $2N$ at each site. Our goal is to evaluate measures of kinship, such as the probability of identity by descent. In particular, we find limit laws for the time it takes two lineages to coalesce as both the torus size L and the colony size N become large. The exact results depend on the limit of $N/(logL)$.

Invariance Principles for Studentized Partial Sum Processes

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Abstract.
Let $X, X_1, X_2, \ldots$, be i.i.d. non-degenerate random variables, $S_n = \sum_{j=1}^{n} X_j$ and $V_n^2 = \sum_{j=1}^{n} X_j^2$. In [1] we investigate the asymptotic behavior in distribution of the maximum of self-normalized sums, $\max_{1 \le k \le n} S_k/V_k$, and the law of the iterated logarithm for self-normalized sums, S_n/V_n, when X belongs to the domain of attraction of the normal law. In this context, we establish a Darling-Erdős type theorem as well as an Erdős-Feller-Kolmogorov-Petrovski type test for self-normalized sums. In [2] we show that a self-normalized version of Donsker's theorem holds only under the assumption that X belongs to the domain of attraction of the normal law. Weighted approximations for the sequence of self-normalized partial sum processes $\{S_{[nt]}/V_n,\ 0 \le t \le 1\}$, with applications to arc sine law and changepoint problems, are also established. This presentation will review some of the results of [1] and [2].

References

1. M. Csörgő, B. Szyszkowicz, Q. Wang, Darling-Erdős Theorems for Self-normalized Sums, *Technical Report Series of the Laboratory for Research in Statistics and Probability,* No. 354-July 2001, Carleton University - University of Ottawa.

2. M. Csörgő, B. Szyszkowicz, Q. Wang, Donsker's Theorem and Weighted Approximations for Self-normalized partial sums processes, *Technical Report Series of the Laboratory for Research in Statistics and Probability,* No. 360-October 2001, Carleton University - University of Ottawa.

Analysis on loop groups

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Abstract.
Let G be a compact Lie group and L(G) denote the space of continuous loops based at the identity, e, in G. In this talk we will discuss a number of results pertaining to analysis on L(G) equipped with two probability measures. One measure will be pinned Wiener measure while the other is "heat kernel" measure. The second measure is taken to be the endpoint distribution of an L(G) – valued Brownian motion.

Infinitely Many Neutral Alleles Model: Large Deviation and Quasi-Potential

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Abstract.
The talk will start with a brief review on large deviations of a potential system under small strong elliptic random perturbations. The infinitely many neutral alleles model can be viewed as a random perturbation of a dynamical system in infinite dimension. Since the perturbation coefficient is degenerate and non-Lipschitz, more detailed study of the boundary behaviour is done to establish the LDP and identify the quasi-potential. An intuitive sketch of proof will be presented. New results in the talk are joint work with D.A. Dawson, and with J. Xiong.

Recent progress in catalytic branching I,II

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Abstract.

Spatial branching models with a varying branching mechanism are often called catalytic branching processes. The branching population is meant to be a reactant which is influenced by a varying medium, the catalyst. We focus on two very particular cases.

In the first model, the catalyst is described by an autonomous stable random measure. Here the catalyst consists of a countable number of weighted points densely located in space. The main interest in this model comes from the fact that this catalyst has an infinite expectation. The model was founded jointly with Don Dawson in the late 1980s but it remained open, whether from a macroscopic point of view the reactant's clumps are spatially separated or not. Recent progress was achieved together with Dawson and Mörters.

In the second model, the two materials are now equitable: Each one serves as a catalyst for the other one's branching. This interaction destroys the traditional branching property, based on independence assumptions. The mutually catalytic branching model was created by Dawson and Perkins (1998) and Mytnik (1998). Recent progress concerns a two-dimensional continuum version, presented in a trilogy of manuscripts jointly with Dawson, Etheridge, Mytnik, Perkins, and Xiong we try to survey.

k-strong/weak transience and random walks on the hierarchical group

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Abstract.
We discuss the notions of k-strong and k-weak transience of random walks on locally compact Abelian groups and their relationships with multilevel branching and last exit times, and we consider the case of random walks on the hierarchical group.

Multitype spatial population models

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Abstract.

We consider the class of spatially distributed branching systems with two types of individuals as a $((\mathbb{R}^+)^2)^\Omega$ diffusion process, where the site space is a countable group for example $\mathbb{Z}^d$ or the hierarchical group Ω_M. The focus is on the determination of the universality classes for the longterm behavior.

In the first part of the lecture the case of mutually catalytic branching on the hierarchical group and the continuum limit with respect to the site space are analysed using the method of renormalisation by multitype space-time scales and then taking the hierarchical mean-field limit. This allows to introduce the interaction chain and the small-scale characteristics as the limiting objects. These properties determine the large-scale or small-scale behavior respectively in the case of the continuum limit. We discuss the dichotomies coexistence versus monotype and densitites of the continuum limit versus singular states.

In the second part of the lecture we discuss two-type branching with a branching rate depending on the total mass and catalytic branching and resampling systems. In the latter case we focus on Fisher-Wright diffusions in a voter model medium with site space $\mathbb{Z}^d$ and describe the longtime behavior for $d \geq 3$ and in the cases $d = 1$ and $d = 2$ where now phenomena arise.

The described results are obtained in joint work with T. Cox, D. Dawson, A. Klenke and A. Wakolbinger.

Large deviations for optimal local sequence alignments

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Abstract.

When comparing two long DNA or amino acid sequences one might look whether there are subpieces of the sequences which match each other well. A more realistic way of comparing the sequences is to allow also *gaps*, which means that one can shift parts of the subpieces against each other.

Any possible way to compare any two subpieces using gaps is called a *local alignment* of the sequences. For each such alignment a score is defined which increases in the similarity of the two aligned subpieces. Algorithms are available which find the optimal one among all alignments in reasonable time. The score of this optimal alignment is considered to be a good measure of the relatedness of the whole sequences.

From a statistical point of view it is important to understand the distribution of this optimal score for random unrelated sequences. Up to now this has only been solved in the gapless case.

We show that, in an appropriate large deviations regime, the tail of this distribution decays exponentially with a rate of decay which is strictly smaller than in the gapless case. We characterize this rate in two ways. First it is related naturally to the growth of typical alignment scores. On the other hand it is given by the zero of some limiting logarithmic moment generating function. This result extends nicely the gapless case. We also give bounds which are helpful for determining the rate in practice.

Super-Brownian Motion with Random Immigration

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Abstract.

Longtime behavior for the SBMSBI is considered, for the occupation time of the SBMSBI, a central limit theorem is obtained in dimension $d \geq 3$ with the right norming $a_d(t)$ being $t^{(10-d)/4}$ for $3 \leq d \leq 6$, and t for $d \geq 7$, that leads to some Gaussian random fields: for $3 \leq d \leq 5$, the field is spatially uniform; for $d \geq 7$, the covariance of the limit field is given by the potential operator of the underlying Brownian motion; and for $d = 6$, the limit field involves a mixture of the two kinds of fluctuations. An ergodic theorem is proved as well for dimension $d = 2$, which characterized by an evolution equation.

Large deviation principles are established in dimensions $d \geq 3$ for the SBMSBI. The speed function is t for $d \geq 4$ and $t^{1/2}$ for $d = 3$, compared with the existing results, the interesting phenomenon happened in $d = 4$ with speed t (although only the upper large deviation bound is derived here) is just because the structure of this new model: the random immigration "smooth" the critical dimension in some sense. The rate function are characterized by Dynkin's moment formula for $d \geq 4$ and by an evolution equation for $d = 3$.

For the level-2 superprocess, the random immigration has been considered as well.

The Galton-Watson tree size-biased according to its total progeny

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Abstract.
Let T be a subcritical Galton-Watson family tree and let $\hat{T}^k$ denote a random tree whose distribution is that of the k-times size-biased T, where the size of a tree is the total number of vertices and k is some nonnegative integer. The random family tree $\hat{T}^k$ has a simple probabilistic structure if decomposed along the lines of descent of k distinguished vertices (k-tree) chosen purely at random without replacement. This decomposition of the tree allows a simple analysis of the asymptotic behavior of the tree structure and the total progeny as branching gets critical: The structure of the reduced k-tree has a certain limit, which is binary in case of an offspring distribution with finite variance and the suitably rescaled k-times size-biased total progeny has a gamma limit law.

Continuous and discrete space particle filters

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Abstract.
Nonlinear filtering has a rich mathematical history and is now being recognized as a powerful computational tool. We review some classical nonlinear filtering theory for Markov signals, discuss computer workable approximate filtering algorithms of both continuous- and discrete-state natures, consider annealed and quenched convergence of these algorithms, and introduce a particular non-Markov filtering problem motivated by the search and rescue industry. We work with both continuous-time and industrially-relevant discrete-time problems. Motivating simulations and comparisons, based upon some prototypical problems of our industrial partners, will also be given.

Dealing with spatial and demographic structure in coalescent theory

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Abstract.
Consider a Wright-Fisher model indexed by a parameter N that indicates the order of magnitude of the population size. We discuss convergence, as $N \to \infty$, of the scaled ancestral process to a time-changed version of the standard (possibly structured) coalescent when there are various kinds of structure in the model. In situations where the population is spatially, temporally or otherwise structured via "migration" acting on several different time scales, we show how the limiting coalescent simplifies, with effective coalescence rates computed by averaging rates within groups connected by fast migration. This results in a linear time change of the usual structured coalescent and relates to the biologists' notion of effective population size. In the case of stochastically varying demography, consider a single population whose size scales in such a way that "macroscopic" changes occur on the same time scale as coalescence events. If the limiting backward population-size process is a nice one-dimensional diffusion, X, we show that the corresponding coalescent process is given by the standard coalescent run on a nonlinear time scale which is determined by the local time of X.

Particle Representations with Moving Levels

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Abstract.
A class of particle systems is considered in which each particle has a “type” or “location” in a state space E and a “level” in $[0, \infty)$. At each time t, the collection of particles $\{(X_i(t), U_i(t))\}$ has the property that, conditional on a random measure $K(t) \in \mathcal{M}(E)$, the particles determine a Poisson random measure with mean measure $K(t) \times m$, where m is Lebesgue measure on $[0, \infty)$. In particular, K can be a superprocess with branching rates depending on location in E. Then each particle moves according to the underlying Markov process on E, gives birth to new particles with initial levels above it, and lives until its level hits ∞.

Representations of the symmetric group and moments of random Hermitian matrices with Wishart distribution

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Abstract.

We start with a random variable Z valued in a r dimensional Hermitian space H with Gaussian distribution $N(0,\sigma)$ (ie σ is a positive definite endomorphism of H and $\mathbf{E}(\exp(\langle h, Z\rangle)) = \exp(\langle h, \sigma h\rangle/2)))$. Denote by V the space of Hermitian endomorphisms of H. If $Z_1, \ldots, Z_p$ are independent copies of Z the random variable in V defined by

$$S = \frac{1}{2}(Z_1 Z_1^* + \cdots + Z_p Z_p^*)$$

satisfies $\mathbf{E}(\exp(-\mathrm{trace}(\theta, S)) = (\det(\mathrm{id}_H - \theta\sigma))^{-p}$ for all positive θ in V. More generally, if $p \in \{1, 2, \ldots, r-1\} \cup (r-1, \infty)$ a r.v. S in V satisfying the above equality is said to have the (complex) Wishart distribution $\gamma_{p,\sigma}$. In order to compute the moments of S we use the multilinear forms $r_\pi(\sigma)(h_1, \ldots, h_k)$ on V where π belongs to the group $\mathcal{S}_k$ of permutations of $(1, 2, \ldots, k)$. For instance, if $\pi = (4)(2,5)(6,3,1)$ the form $r_\pi(\sigma)$ is defined by

$$r_\pi(\sigma)(h_1, \ldots, h_6) = \mathrm{trace}(\sigma h_4)\mathrm{trace}(\sigma h_2 \sigma h_5)\mathrm{trace}(\sigma h_1 \sigma h_6 \sigma h_3).$$

Denote by $m(\pi)$ the number of cycles in π, denote by $*$ the convolution operation in the group algebra $\mathcal{A}(\mathcal{S}_k)$ and write q for $r - p$. We prove the following two results

$$\mathbf{E}(r(S)) = p^m * r(\sigma), \quad r(\sigma^{-1}) = (-1)^k * \mathbf{E}(r(S^{-1})).$$

We finally explain how to use the characters of $\mathcal{S}_k$ for inverting the second formula and for getting the moments of S^{-1}. This is joint work with P. Graczyk (Angers) and H. Massam (York).

A Poisson model for gapped local alignments

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Abstract.
High score alignments of DNA sequences give evidence of a common ancestry or function. It is therefore natural to ask whether an observed high score could have arisen by pure chance, and to explore what the high score alignments look like under the null hypothesis of unrelated sequences. We introduce and investigate a simple Poisson model which reflects important features of high score gapped local alignments of independent sequences.

Finite system scheme of catalytic interacting Feller diffusions on the lattice

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Abstract.
We consider catalytic interacting Feller branching diffusions on $\mathbb{Z}^d$ for $d \geq 3$ (transient case). We show to what extent this process can be approximated by processes on $([0, N-1] \cap \mathbb{Z})^d$ (equipped with torus topology). This includes an analysis on two different timescales dependent whether one thinks of macroscopic effects or has a microscopic point of view in mind. The results can be formulated in terms of a "Finite system scheme". They are proven by an extensive use of duality.

Degenerate Stochastic Differential Equations with Hölder Continuous Coefficients and Super-Markov Chains

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Abstract.
We consider the operator $\sum_{i,j=1}^{d} \sqrt{x_i x_j}\gamma_{ij}(x)\frac{\delta^2}{\delta x_i \delta x_j} + \sum_{i=1}^{d} b_i(x)\frac{\delta}{\delta x_i}$ acting on functions in $C_b^2(\partial R_+^d)$. We prove uniqueness of the martingale problem for this degenerate operator under suitable nonnegativity and regularity conditions on γ_{ij} and b_i. In contrast to previous work, the b_i need only be nonnegative on the boundary rather than strictly positive, at the expense of the γ_{ij} and b_i being Hölder continuous. Applications to super-Markov chains are given. The proof follows Stroock and Varadhan's perturbation argument, but the underlying function space is now a weighted Hölder space and each component of the constant coefficient process being perturbed is the square of a Bessel process.

Multitype branching processes on the lattice: infinite and large finite systems

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Abstract.
e study branching processes on the lattice $\mathbb{Z}^d$. Starting from a branching random walk we come up to a multitype branching model. The particles in this model have some type $u \in [0, 1]$, migrate on the lattice due to some random walk and branch. The branching rate for a particle at $\xi \in \mathbb{Z}^d$ in our model is a function of the total mass at ξ. We develop the finite system scheme for this model, i.e. the comparison between infinite systems on $\mathbb{Z}^d$ and large finite systems on $(-N; N] \cap \mathbb{Z}^d$. We put our focus on problems arising from the multitype situation.

Central Limit Theorems for Martingales

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Abstract.
Martingales are quite important in proving asymptotic properties of occupation times of particle systems (weak convergence, large deviations), in maximum likelihood estimation or in financial modelling. In this talk, I will give some conditions in order that the martingales converges to a Brownian motion evaluated at a random independent time.

On limits of branching particle systems in a spatially correlated random medium

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Abstract.

We are investigating relations of branching particle systems in a spatially correlated random environment to the heat equation on $\mathbb{R}^d$ with a coloured noise term. The latter SPDE has function valued solutions in any dimension, in contrast to the heat equation with white noise, which characterises Super-Brownian-Motion only in dimension one.

In this talk we show that the particle system converges to a solution of the martingale problem associated with the SPDE in the linear case. In considering a discrete state space, we obtain convergence to related stepping stone models. We prove in turn that approximate densities of rescalings of such systems converge to the heat equation with coloured noise for a large class of noise coefficients. Questions of existence and uniqueness of the limiting SPDE as well as connections to the white noise equation are discussed.

The trimmed tree of a super-Wright-Fisher diffusion

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Abstract.

In a supercritical branching particle system, the trimmed tree consists of those particles which have descendants at all times. We develop this concept in the superprocess setting. For a class of continuous superprocesses, we identify the trimmed tree, which turns out to be a binary branching particle system with a new underlying motion that is an h-transform of the old one. We apply our results to study the long-time behavior of a super-Wright-Fisher diffusion.

This is joint work with Klaus Fleischmann (WIAS Berlin).

Hierarchical mean field limits of one- and two-level branching systems: a review and a preview

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Abstract.
Consider a homogeneous critical branching population with an individual random walk migration on the hierarchical group Ω_N. In the limit $N \to \infty$, its equilibrium state exhibits a beautiful and transparent structure, provided the individual migration is transient but on the border to recurrence. (This is guaranteed if an individual jumps a hierarchical distance k at rate $r_k = c_k N^{-k}$ with summable c_k). The equilibrium genealogy is then described by a cascade of equilibrium states of subcritical Feller diffusions (X_k) with immigration, where X_{k+1} provides the immigration rate for building up X_k. The (X_k) describe the mean particle numbers in a sequence of nested blocks, which fluctuate at different time scales. This is classical work of Dawson and Greven, which we will review shortly.

Now consider an individual migration which is *strongly* transient but on the border to weak transience. (Strong transience means that a path escapes from a bounded set in *expected* finite time. For the simple random walk on $\mathbb{Z}^d$, strong transience happens in dimension $d > 4$.) For the hierarchical random walk, the right condition for being "just a little bit strongly transient" essentially turns out to be $r_k = c_k N^{-k/2}$ with summable c_k^{-2}, cf. Luis Gorostiza's lecture. With such a migration, a similar picture as described above emerges if one considers a model in which not only individual particles but whole families perform a critical branching. The strong fluctuations of particle numbers generated by this "two-level branching" adequately balance the strong smoothing generated by the strongly transient migration. A candidate for describing the equilibrium genealogy of the mean field limit is now a cascade of Super–{subcritical Feller diffusions with immigration}, whose presentation and analysis will be a main issue of our talk. (This is ongoing work with Don Dawson and Luis Gorostiza.)

A Class of Interacting Superprocesses with Location Dependent Branching

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Abstract.
In Dawson-Li-Wang (Electronic Journal of Probability, 2001 Vol6,25, p.1-33), a class of interacting superprocesses with location dependent branching has been constructed and studied. In my talk, I'll give a criterion for the state classification of this class of superprocesses and discuss their other properties with different assumptions.

Representation theorems for historical interacting Fisher-Wright diffusions

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Abstract.

We consider spatially interacting Moran models and their diffusion limit which are interacting Fisher-Wright diffusions. For both models the historical process is constructed, which gives information about genealogies. For any fixed time, particle representations for the historical process of a collection of Moran models with increasing particle intensity and of the limiting interacting Fisher-Wright diffusions are provided on one and the same probability space by means of a look-down process.

It will be discussed how this can be used to obtain new results on the long term behavior. In particular, we give representations for the equilibrium historical processes. Based on the latter the behavior of large finite systems in comparison with the infinite system is described on the level of the historical processes.

The talk is based on joint work with Andreas Greven and Vlada Limic.

Mass-time-space scaling of a super-Brownian catalyst reactant pair

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Abstract.
The one-dimensional super-Brownian reactant X^{ϱ} with a super-Brownian catalyst ϱ has a jointly continuous density field satisfying a stochastic partial differential equation. Consider any expectation preserving mass-time-space scaling of X^{ϱ} Using the density field, one can pass to an fdd scaling limit of the measure-valued process, which degenerates also under the critical scaling of ϱ. For some of the scaling indexes, convergence on path spaces holds, too. This talk is based on a joint work with K. Fleischmann.

Regularity of catalytic super Brownian motions

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Abstract.

The catalytic super Brownian motion having a time-constant catalyst $\rho(dx)$ will be considered in dimension 1. That means we focus on the high-density/short-lifetime measure-valued diffusion limit of a branching Brownian particle system where the branching rate of a particle at position x_0 is governed by "$\frac{\rho(dx)}{dx}(x_0)$". On the one hand conditions on the catalyst implying the existence of a jointly continuous density field will be established and discussed. On the other hand we characterize the density field as the unique solution to a certain stochastic partial differential equation.

Functional Central Limit Theorems for Branching Random walk

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Abstract.

We study fluctuations of the occupation time of a stationary branching random walk $(\xi_t)_{t \geq 0}$ on $\mathbb{Z}^d$, $d \geq 3$. A functional central limit theorem for $\int_0^t \xi_t(0)\,dt$ is proven. For $d = 3$ the scaling function $t^{-3/4}$ leads to convergence to fractional Brownian motion, while for $d = 4$ and $d \geq 5$ the scalings $(t \log t)^{-1}$ resp. $t^{-1/2}$ cause convergence to Brownian motion. The methods are based on recent work by Quastel, Jankowski and Sheriff.

This is joint work with Matthias Birkner and Anton Wakolbinger (Frankfurt), which is still in progress.

Coalescing Brownian motion

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Abstract.
Two kinds of dualities are discussed in this talk. We first point out a dual relationship between coalescing Brownian motions and annihilating Brownian motions. Such a duality is similar to the one in voter model and it can be used in the study of stepping-stone models. The other duality is between two coalescing Brownian motions. More precisely, the distribution of a coalescing Brownian motion at time t can be determined by another coalescing Brownian motion running backward. We will then try to formulate a martingale problem for coalescing Brownian motions using the above duality.