Detailed Program

Friday, August 13, 2010

08:00 - 09:00 **Registration**

09:00 - 10:00 **Plenary Session** *Venue: Auditorium (main)*
(*Chair: Antar Bandyopadhyay, Indian Statistical Institute, Delhi*)

Alain-Sol Sznitman, *ETH, Zurich*
Random interlacements

Random interlacements are a Poissonian cloud of doubly infinite paths modulo time-shift, which yields a microscopic model for the trace left at suitably selected time scales by random walks on large recurrent graphs, which are locally transient. Random interlacements have recently been helpful in understanding, among other things, the way in which random walk trajectories can create large disconnecting interfaces. We will review in this talk some of the recent developments.

Keywords : random interlacements, random walks, percolation, disconnection

AMS Classification Numbers : 60K35, 60G50, 82C41

10:00 - 11:00 **Plenary Session** *Venue: Auditorium (main)*
(*Chair: Bhamidi Visweswara Rao, Chennai Mathematical Institute*)

Andrea Montanari, *Stanford University*
Message passing algorithms, random convex problems, and the risk of the LASSO

The problem of estimating a high-dimensional vector from a set of linear observations arises in a number of engineering disciplines. It becomes particularly challenging when the underlying signal has some non-linear structure that needs to be exploited. I will present a new class of iterative algorithms inspired by probabilistic graphical models and statistical mechanics ideas, that appear to be asymptotically optimal in specific contexts. The analysis of these algorithms allows to prove remarkably sharp results on the asymptotic behavior of some families of random convex problems. I will in particular discuss the mean square error for LASSO estimation in the context of compressed sensing problems. [Based on joint work with David L. Donoho and Arian Maleki, and with Mohsen Bayati and Jose Bento.]

Keywords : message passing, convex geometry, LASSO, compressed sensing

AMS Classification Numbers : 60F99, 68W99, 62H12

11:00 - 11:30 **Coffee Break**

11:30 - 13:15 **Invited Session: Random Media** *Venue: Auditorium (main)*
(*Chair: Erwin Bolthausen, University of Zurich*)

11:30 **Noam Berger**, *Hebrew University of Jerusalem*
Unsatisfied edges in 2D spin glass ground states do not percolate

We define the Edwards-Anderson Ising Spin Glass model in the planar square lattice and survey some results about it. We then define the notion of unsatisfied edges (in ground states of the above model) and prove that they do not percolate.

This is joint work with Ran Tessler.

Keywords : spin glass, ground state, Edwards-Anderson model

AMS Classification Numbers : 60K35, 60K37

12:05 **Vladas Sidoravicius**, *CWI/IMPA*
Random walks and random growth in dynamic random environment

I will focus on two questions: 1. Diffusion Limited Aggregation type growth model evolving in a dynamic random environment, constituted by infinitely many particles, performing simple symmetric random walks independently of each other, and sticking to the DLA-cluster, once they hit it. The number of particles in the system is preserved during the evolution. The difference from the canonical Sander-Witten model is that in this case multiple particles are simultaneously affecting shape of the cluster. I will show, that there is a phase transition in the initial density of the environment particles, which separates linear and sub-linear growth regions, and, as a consequence, limiting shapes of the aggregate.

2. Random walks in dynamic random environment. Consider a particle, call it W-particle, moving in a random environment, where the jump probabilities of W-particle are affected by the environment. As in the model 1 above, the environment is constituted by the system of infinitely many particles performing simple symmetric random walks, independently of each other, and once W-particle is on the empty vertex, it has drift in a direction u, and if it shares a vertex with the environment particle it has opposite drift $(-u)$. Again, there is a transition in the behavior of W-particle, which depends on the density of environment particles.

What relates these two questions are techniques which we use to analyze above models, and I will present some technical aspects of multi-scale analysis, and regeneration time approach which are used in our work.

The talk is based on works in collaboration F. den Hollander, M. Hilario and H. Kesten.

Keywords : DLA, random walk in random environment, regeneration time

AMS Classification Numbers : 60K35, 60J25, 82C24

12:40 **Gerard Ben Arous**, *Courant Institute, New York University*
Complexity of spin glass energy landscapes and random matrices

This is joint work with C.A. Auffinger (Courant) and J.Cerny (ETH Zurich).

Random Matrix Theory and the Kac-Rice formula allow a very precise counting of the mean number of critical points (of given index and given energy value) for spherical spin glasses hamiltonian. A detailed picture of the shape of the energy landscape emerges, which is rather different for the pure p-spin case and for mixed cases. I will dwell on recent progress for general cases.

Keywords : spin glasses, random matrices, complexity

AMS Classification Numbers : 15A52, 52C45, 60G15, 60K35

11:30 - 13:15 **Invited Session: Malliavin Calculus** *Venue: SSIU seminar hall*
(*Chair: Arturo Kohatsu-higa, Osaka University*)

11:30 **Giovanni Peccati**, *Luxembourg University*
Universal Gaussian fluctuations on Wiener chaos

We show how to compute explicit bounds in the normal and chi-square approximations of multilinear homogenous sums (of arbitrary order) of general centered independent random variables with unit variance. Our techniques combine an invariance principle by Mossel, O'Donnell and Oleszkiewicz with a refinement of some recent results by Nourdin and Peccati, about the approximation of laws of random variables belonging to a fixed (Gaussian) Wiener chaos. In particular, we will show that chaotic random variables enjoy the following form of *universality*: (a) the normal and chi-square approximations of any homogenous sum can be completely characterized and assessed by first switching to its Wiener chaos counterpart, and (b) the simple upper bounds and convergence criteria available on the Wiener chaos extend almost verbatim to the class of homogeneous sums. These results partially rely on the notion of "low influences" for functions defined on product spaces, and provide a generalization of several central and non-central limit theorems for smooth functionals of Gaussian fields. They also imply a further drastic simplification of the method of moments and cumulants – as applied to the proof of probabilistic limit theorems – and yield substantial generalizations, new proofs and new insights into some classic findings by de Jong and Rotar'. Our tools involve the use of Malliavin calculus, and of both the Stein's method and the Lindeberg invariance principle for probabilistic approximations.

References

[1] I. Nourdin and G. Peccati (2009). Stein's method on Wiener chaos. *Probab. Theory Rel. Fields* **145**, no. 1, 75-118.

[2] I. Nourdin, G. Peccati and G. Reinert (2009). Invariance principles for homogeneous sums: universality of Gaussian Wiener chaos. To appear in: *Ann. Probab.*

[3] D. Nualart and G. Peccati (2005). Central limit theorems for sequences of multiple stochastic integrals. *Ann. Probab.* **33** (1), 177-193.

[4] E. Mossel, R. O'Donnell and K. Oleszkiewikz (2008). Noise stability of functions with low influences: variance and optimality. To appear in: *Ann. Math.*.

[5] G. Peccati and M.S. Taqqu (2010). *Wiener Chaos: Moments, Cumulants and Diagrams.* Springer Verlag.

Keywords : limit theorems, universality

AMS Classification Numbers : 60F05, 60F17, 60G15, 60H07

12:05 **Jonathan Mattingly**, *Duke University*
Malliavin Calculus to prove ergodic theorems for SPDEs

I will give a tour of a collections of techniques based on Malliavin calculus which have been developed to prove ergodic theorems for degenerate diffusions on infinite dimensional spaces, such as the configuration space of an Stochastic Partial Differential equation (SPDE). This will include a discussion of non-adapted estimates and a partial integration by parts formula. The goal will be to prove an infinite dimensional version of Hormander's "Sum of Squares Theorem" for dissipative SPDEs. Such questions, in the finite dimensional setting were, the original motivation for the development of Malliavin calculus. The talk will be based on joint work with Martin Hairer, Etienne Paradox and Yuri Bakhtin.

Keywords : stochastic partial differential equation (SPDE), Malliavin calculus, ergodic theorem

AMS Classification Numbers : 37A25, 37A60, 37N10, 37L55, 60H15, 60H07, 35R60

12:40 **Arturo Kohatsu-higa**, *Osaka University*
A Malliavin calculus method to study SDE's with irregular drifts

Until recently it was thought that Malliavin Calculus was a tool to be used with diffusions with smooth coefficients. We present a general method which allows to use Malliavin Calculus for stochastic equations with irregular drift. This method uses the Girsanov theorem combined with Ito-Taylor expansion in order to obtain regularity properties for the density of a hypoelliptic random variable at a fixed time. We apply the methodology to the case of the Lebesgue integral of a diffusion.

This is joint work with Akihiro Tanaka.

Keywords : Malliavin calculus, SDE with irregular drift

AMS Classification Numbers : 60F05, 60F10, 60F17

11:30 - 13:15 **Contributed Session: Games and Control** *Venue: Auditorium (seminar hall)*
(*Chair: Leonid Mytnik, Technion - Israel Institute of Technology*)

11:30 **Alberto Algergo Pinto**, *University of Porto*
Hotelling model with uncertainty on the production cost and networks

First, we find the ex-ante and ex-post prices of the Hotelling model with uncertainty on the production cost of both firms. Secondly, we introduce a new Hotelling-type network game, where each firm i is represented by a node of degree k_i, the number of firm i's direct competitors (neighbors). We investigate price competition a la Hotelling with complete and incomplete information about the network structure. The goal is to investigate the effects of the network structure and of the uncertainty on firms' prices and profits.

References

[1] A. A. Pinto, *Game Theory and Duopoly Models*. Interdisciplinary Applied Mathematics series, Springer-Verlag (2010).

[2] *Dynamics, Games and Science*. Eds: M. Peixoto, A. A. Pinto and D. A. Rand. Proceedings in Mathematics series, Springer-Verlag (2010).

[3] A. A. Pinto, D. A. Rand and F. Ferreira, *Fine Structures of Hyperbolic Diffeomorphisms*. Springer-Verlag Monograph (2009).

Keywords : Hotelling model, networks, uncertainty

AMS Classification Numbers : 90B15, 91A43

12:05 **K.S. Mallikarjuna Rao**, *Indian Institute of Technology Bombay*
Nash equilibrium in stochastic games and its approximation

Using the fact that any two player discounted stochastic game with finite state and action spaces can be recast as a non-convex constrained optimization problem, where each global minima corresponds to a stationary Nash equilibrium, we present a sequential quadratic programming based algorithm that converges to a KKT point. This KKT point is an ϵ-Nash equilibrium for some $\epsilon > 0$ and under some suitable conditions we show that this KKT point corresponds to a stationary Nash equilibrium. The algorithm updates the Hessian matrix of the Lagrangian function in a specific way. We illustrate various difficulties that can arise while computing stationary Nash equilibrium of the stochastic game using a variant of pollution tax model. One interesting feature of this model (in an instance) is that it admits a Nash equilibrium which is independent of the discount factor close to 1, an extension of Blackwell optimality in Markov decision processes.

Keywords : nonzero-sum stochastic game, discounted value, multiple Nash equilibria, ϵ-Nash equilibrium, non-convex constrained optimization, sequential quadratic programming, Lagrange multipliers, MFCQ condition, regular point, pollution tax model

AMS Classification Numbers : 91A15, 90C26, 91B76

12:40 **Anup Biswas**, *TIFR Centre for Applicable Mathematics*
Exit time and invariant measure asymptotics for small noise constrained diffusions

Constrained diffusions, with diffusion matrix scaled by small $\epsilon > 0$, in a convex polyhedral cone $G \subset \mathcal{R}^k$, are considered. Under suitable stability assumptions small noise asymptotic properties of invariant measures and exit times from domains are studied. Let $B \subset G$ be a bounded domain containing 0. Under conditions, an "exponential leveling" property that says that, as $\epsilon \to 0$, the moments of functionals of exit location from B, corresponding to distinct initial conditions coalesce asymptotically at an exponential rate, is established. Result of this type in unconstrained settings was done by Martin V. Day. This result was obtained by using regularity results from elliptic partial differential equations. But in the constrained settings we can not adopt the same technique due to the irregular nature of boundary of the cone G. We use a probabilistic method based on pseudo atom approach which bypasses the pde estimates. It is also shown that, with appropriate conditions, difference of moments of a typical exit time functional with a sub-logarithmic growth, for distinct initial conditions in suitable compact subsets of B, is asymptotically bounded. Furthermore, as initial conditions approach 0 at rate ϵ^2 these moments are shown to asymptotically coalesce at an exponential rate. Result of these types are totally new and not even known in unconstrained settings.

This work is done with Amarjit Budhiraja.

Keywords : large deviations, constrained diffusions, Skorohod problem, small noise asymptotics, exit time, exponential leveling, split-chains, pseudo-atom, Lyapunov functions, invariant measures

AMS Classification Numbers : 60F10, 60J60, 60J25

13:15 – 14:30 **Lunch**

14:30 - 16:15 **Invited Session: Concentration Inequalities** *Venue: Auditorium (main)*
(*Chair: Mokshay Madiman, Yale University*)

14:30 **Kavita Ramanan**, *Brown University*
Concentration inequalities for dependent random variables

We will describe an approach that combines the martingale method with linear programming techniques to derive concentration inequalities for dependent random variables. Applications to Markov chains and hidden Markov chains will also be illustrated.

This is based on joint work with Leonid Kontorovich.

Keywords : concentration inequalities, martingale method, mixing coefficients, hidden Markov chains

AMS Classification Numbers : 60E15, 60J10, 60G42

15:05 **Andrea Montanari**, *Stanford University*
Some concentration questions in random constraint satisfaction problems

Let $Z(F)$ be the number of solutions of a random k-satisfiability formula F with n variables and clause density α. It was proved by Ehud Friedgut that the property $\{Z(F) > 0\}$ undergoes a sharp threshold when the clause density increases.

It is a common conjecture that, when $Z(F) > 0$ with high probability, the normalized logarithm of the number of solutions concentrates. Namely there should exists a non-random function $\alpha \mapsto f(\alpha)$ such that, for any $\delta > 0$, $(1/n) \log Z(F) \in [f - \delta, f + \delta]$ with high probability.

We prove the conjecture under the stronger assumption that the probability that F is unsatisfiable is

$$O(1/\log(n)^{1+a})$$

for $a > 0$. In particular, the assumption holds for all $\alpha < 1$, which proves the above concentration claim in the whole satisfiability regime of random 2-SAT. We also extend these results to a broad class of constraint satisfaction problems.

Keywords : concentration of measure, constraint satisfaction problems, sharp thresholds

AMS Classification Numbers : 68R05, 60C05

15:40 **Pierre Del Moral**, *INRIA*
Concentration inequalities for mean field particle models

This talk is concerned with the fluctuations and the concentration properties of a general class of discrete generation and mean field particle interpretations of non linear measure valued processes. We combine an original stochastic perturbation analysis with a concentration analysis for triangular arrays of conditionally independent random sequences, which may be of independent interest. Under some additional stability properties of the limiting measure valued processes, uniform concentration properties with respect to the time parameter are also derived. The concentration inequalities presented here generalize the classical Hoeffding, Bernstein and Bennett inequalities for independent random sequences to interacting particle systems, yielding very new results for this class of models. We illustrate these results in the context of McKean Vlasov type diffusion models, McKean collision type models of gases, and of a class of Feynman-Kac distribution flows arising in stochastic engineering sciences and in molecular chemistry.

This is joint work with Rio Emmanuel.

References

[1] Pierre Del Moral, Rio Emmanuel. Concentration inequalities for mean field particle models, *HAL-INRIA RR-6901* [21p], [submitted] (April 2009).

Keywords : concentration inequalities, mean field particle models, measure valued processes, Feynman-Kac semigroups, McKean-Vlasov models

AMS Classification Numbers : 65C35, 60B10

14:30 - 16:15 **Invited Session: SPDE** *Venue: SSIU seminar hall*
(*Chair: Martin Hairer, University of Warwick*)

14:30 **Jeremy Quastel**, *University of Toronto*
Exact distribution function for the free energy of the continuum directed random polymer and KPZ in one dimension

We consider the solution of the stochastic heat equation $\partial_t Z = \frac{1}{2}\partial_x^2 Z - Z\dot{W}$ with specially chosen initial data, whose logarithm is the free energy of the continuum directed polymer, or the Hopf-Cole solution of the Kardar-Parisi-Zhang equation.

Through a steepest descent analysis of the Tracy-Widom formulas for the asymmetric simple exclusion we obtain explicit formulas for the one-dimensional marginal distributions.

This is applied to discrete directed polymers in a scaled, intermediate disorder regime, which interpolates between weak and strong disorder.

This is joint work with Tom Alberts, Gidi Amir, Ivan Corwin and Kostya Khanin.

Keywords : Kardar-Parisi-Zhang equation, stochastic heat equation, stochastic Burgers equation, random growth, asymmetric exclusion process, anomalous fluctuations, directed polymers

AMS Classification Numbers : 82C22, 60H15

15:05 **Leonid Mytnik**, *Technion - Israel Institute of Technology*
Infinite rate mutually catalytic branching model

Consider the mutually catalytic branching process with finite branching rate γ. We show that as $\gamma \to \infty$ this process converges to a process that we call infinite rate mutually catalytic branching model. We study the properties and in particular the long time behavior of the process.

This is a joint work with A. Klenke.

Keywords : mutually catalytic branching, stochastic partial differential equations, long time behavior

AMS Classification Numbers : 60G57, 60H15, 60J80

15:40 **Jan Maas**, *Universität Bonn*
Approximations to stochastic Burgers equations

We consider the 1D-stochastic Burgers equation driven by additive space-time white noise. Although this equation is well-posed, it turns out to be very unstable under approximations of the nonlinearity. In fact we shall prove that various natural approximations converge to different limits. This phenomenon can be explained by the spatial roughness of the solutions.

This is joint work with Martin Hairer.

Keywords : stochastic Burgers equations, finite differences, spatial regularity, concentration inequalities

AMS Classification Numbers : 60H15, 60H35, 35K55

14:30 - 16:50 **Contributed Session:** *Venue: Auditorium (seminar hall)*
Random Geometric Graphs
(*Chair: Ayalvadi Ganesh, University of Bristol*)

14:30 **Anish Sarkar**, *Indian Statistical Institute, Delhi*
Random geometric graphs with densities having a zero

A random geometric graph is defined as follows : for a set of random points in some set $A \subset \mathbb{R}^d$, fix $r > 0$ and connect a pair of points X, Y, provided that $\| X - Y \| < r$. The graph generated with the set of points as the vertices and the random set of edges thus constructed, is called random geometric graph. Previous studies have been conducted under the assumption that the random set of point originate as an iid sample from a density function that is bounded away from 0 on A. We restrict our attention to densities on $[0, 1]$ with exactly one zero at 0. Further, we impose that the density is regularly varying at 0. Under this assumption, we study asymptotic behaviour of connectivity distance of the random geometric graph. Our results show that the connectivity distance behaves differently as compared to the case of densities that are bounded away from 0.

Keywords : random geometric graph, regularly varying function, inhomogeneous Poisson process

AMS Classification Numbers : 60C05, 05C80

15:05 **Debleena Thacker**, *Indian Statistical Institute, Delhi*
Nonuniform random geometric graphs with location dependent radii

We propose a *distribution free* approach to the study of random geometric graphs. The distribution of vertices follows a Poisson point process with intensity function $nf(\cdot)$, where $n \in \mathbb{N}$, and f is a probability density function on $\mathbb{R}^d$. A vertex located at x connects via directed edges to other vertices that are within a *cut-off* distance $r_n(x)$. We prove strong law results for, (i) the critical cutoff function so that almost surely, the graph does not contain any node with out-degree zero for sufficiently large n, (ii) the maximum and minimum vertex degrees. We also provide a characterization of the cut-off function for which the number of nodes with out-degree zero converges in distribution to a Poisson random variable. We illustrate this result for a class of densities with compact support that have at most polynomial rates of decay to zero. Finally, we state a sufficient condition for an enhanced version of the above graph to be almost surely connected eventually.

This is joint work with Srikanth Iyer.

Keywords : random geometric graph, uniform distribution, connectivity

AMS Classification Numbers : 60D05, 60G70, 05C05, 90C27

15:40 **Srikanth K Iyer**, *Indian Institute of Science*
Extended random signal-to-interference-and-noise-ratio graphs with fading

We study the asymptotic properties of a random geometric graph (SINR-F) on uniform points in which a directed link exists between two nodes if the *signal* to *interference-noise* ratio is above a certain threshold. We first study such a graph in the presence of fading effects alone (RGG-F). For this graph we prove an almost sure limit for the critical power required to ensure that the graph does not possess isolated nodes and a criterion under which the number of isolated nodes converges in distribution to a Poisson distribution. We derive a sufficient condition under which the graph will be connected with high probability and derive almost sure bounds on the maximum and minimum vertex degrees. We then prove an almost sure upper bound on the maximum *received interference.* This allows us to choose an asymptotic *spread* parameter so as to bound the maximum received interference. With this choice of spread parameters we can extend the results obtained for RGG-F to SINR-F.

Keywords : random geometric graphs, signal to interference noise ratio, connectivity, vertex degree

AMS Classification Numbers : 60D05, 60G70, 05C05, 90C27

16:15 **Yogeshwaran Dhandapani**, *Ecole Normale Superieure*
Percolation and connectivity in AB random geometric graphs

Given two independent Poisson point processes $\Phi^{(1)}$,$\Phi^{(2)}$ in $\mathbb{R}^d$, the AB Poisson Boolean model is the graph with points of $\Phi^{(1)}$ as vertices and with edges between any pair of points for which the intersection of balls of radius $2r$ centred at these points contains at least one point of $\Phi^{(2)}$. This is a generalization of the AB percolation model on discrete lattices. We show the existence of percolation for all $d \geq 2$ and derive bounds for a critical intensity. We also provide a characterization for this critical intensity when $d = 2$. To study the connectivity problem, we consider independent Poisson point processes of intensities n and cn in the unit cube. The AB random geometric graph is defined as above but with balls of radius r. We derive a weak law result for the largest nearest neighbour distance and almost sure asymptotic bounds for the connectivity threshold.

This is joint work with Srikanth Iyer.

Keywords : random geometric graph, percolation, connectivity, wireless networks, secure communication

AMS Classification Numbers : 60D05, 60G70, 05C05, 90C27

14:30 - 16:50 **Contributed Session:** *Venue: Auditorium (smu)*
Heavy Tails and Related Topics
(*Chair: Gabor Lugosi, ICREA and Pompeu Fabra University*)

14:30 **Koushik Saha**, *Bidhannagar College*
Product of exponentials and spectral radius of random k circulants

Even though the distribution of the g fold product of independent and identically distributed (i.i.d.) random variables have been studied in the literature, there does not seem to be much work on its tail behaviour, when they are in Gumbel domain of attraction. In this talk we first consider the tail behaviour when the random variables are exponentially distributed.

Then we consider $n \times n$ random k-circulant matrices with $n \to \infty$ and $k = k(n)$ whose input sequence $\{a_l\}_{l \geq 0}$ is i.i.d. with finite $(2+\delta)$ moment. We study the asymptotic distribution of the spectral radius, when $n = k^g + 1$. We show that with appropriate scaling and centering, the limit distribution is Gumbel. We also identify the centering and scaling constants explicitly. The proof uses appropriate normal approximation techniques and the above tail behaviour.

This is joint work with Arup Bose and Rajat Subhra Hazra.

Keywords : tail of product, eigenvalues, k-circulant matrix, spectral radius, normal approximation

AMS Classification Numbers : 60B20, 60B10, 60F05, 62E20

15:05 **Rasbagh Vasudeva**, *University of Mysore*
Laws of the iterated logarithm for trimmed sums under domains of partial attraction

In this paper, we obtain the law of the iterated logarithm for the trimmed sums, when the random variables are i.i.d. and in the domain of partial attraction of a semi stable law. In particular, when the random variables are positive valued, we prove law of the iterated logarithm for trimmed sums with a delayed start and also establish an associated renewal theorem.

Keywords : law of the iterated logarithm, trimmed sums, domain of partial attraction, semistable laws

AMS Classification Numbers : 60F15

15:40 **Sreenivasan Ravi**, *University of Mysore*
On some tail bahaviours of distributions

The talk is based on joint work with my former student Mrs. Praveena.

Consider distributions belonging to the max domain of attraction of the Frechet law under power normalization. The proposed talk shall be on some von-Mises type sufficient conditions for a distribution to belong to the max domain of attraction of the Frechet law under power normalization. Several examples illustrating the variety of tail behaviours are included in the talk. The latter part of the talk shall be on distributions that are both subexponential and in the max domain of attraction of the Frechet law under power normalization.

Keywords : Frechet law, power normalization, subexponential distributions

AMS Classification Numbers : 60G70, 60E05

16:15 **Arunangshu Biswas**, *Presidency College*
Process convergence of self normalized sums of i.i.d. random variables coming from domain of attraction of stable distributions

In this paper we show that the continuous version of the self normalised process

$$Y_{n,p}(t) = \frac{S_n(t)}{V_{n,p}} + \frac{(nt - [nt])X_{[nt]+1}}{V_{n,p}},$$

where

$$S_n(t) = \sum_{i=1}^{[nt]} X_i, \quad V_{n,p} = (\sum_{i=1}^{n} \mid X_i \mid^p)^{\frac{1}{p}},$$

and X_i are i.i.d. random variables belonging to $DA(\alpha)$, has a non trivial distribution iff $p = \alpha = 2$. The case for $2 > p > \alpha$ and $p \leq \alpha < 2$ is systematically eliminated by showing that either of tightness or finite dimensional convergence to a non-degenerate limiting distribution does not hold. This work is an ex- tension of the work by Csörgö et al. who showed Donsker's theorem for $Y_{n,2}(\cdot)$, i.e., for $p = 2$, holds iff $\alpha = 2$ and identified the limiting process as standard Brownian motion in sup norm.

This is joint work with Gopal Basak.

Keywords : self-normalised sums, invariance principles, domain of attraction, stable distributions

AMS Classification Numbers : 60F17, 60G52

16:15 – 17:00 Coffee Break

Saturday, August 14, 2010

08:00 - 09:00 **Registration**

09:00 - 10:00 **Plenary Session** *Venue: Auditorium (main)*
(*Chair: Rajeev Bhaskaran, Indian Statistical Institute, Bangalore*)

Maury Bramson, *University of Minnesota*
Stability and tail behavior for randomized load balancing schemes

In this talk, we consider randomized load balancing schemes where an arriving job joins the shortest of d randomly chosen queues from among a pool of n queues. Vvekenskaya, Dobrushin, and Karpelevich (1996) considered the case with Poisson input and exponentially distributed service times, and derived an explicit formula for the equilibrium distribution for fixed d as $n \to \infty$. Since its tail decays doubly exponentially fast, this distribution is useful in various applications.

Relatively little work has been done for general service times or input. For general service times, the behavior of the service rule at each queue will now play a role in the behavior of the system. Even the question of under which conditions the system is stable (i.e., its underlying Markov process is positive recurrent) for fixed n is no longer obvious. One also wishes to understand the limiting tail behavior for such equilibria (provided they exist) as $n \to \infty$, as in the first paragraph.

Here, we discuss the stability of such systems, and extensions of these results that show the associated equilibria are tight when restricted to a finite number of queues and $n \to \infty$. Although the general question regarding the limiting behavior of the equilibria as $n \to \infty$ is open, certain important cases, such as the FIFO service rule, can be analyzed. We also discuss a general ansatz that enables the analysis of a larger family of systems. This material includes joint work with Y. Lu and B. Prabhakar.

Keywords : stochastic network, join the shortest queue, stability

AMS Classification Numbers : 60K25, 68M20, 90B15

10:00 - 11:00 **Plenary Session** *Venue: Auditorium (main)*
(*Chair: Srikanth K Iyer, Indian Institute of Science*)

Gabor Lugosi, *ICREA and Pompeu Fabra University*
Combinatorial testing problems

We study a class of hypothesis testing problems in which, upon observing the realization of an n-dimensional Gaussian vector, one has to decide whether the vector was drawn from a standard normal distribution or, alternatively, whether there is a subset of the components belonging to a certain given class of sets whose elements have been “contaminated,” that is, have a mean different from zero. We establish some general conditions under which testing is possible and others under which testing is hopeless with a small risk. The combinatorial and geometric structure of the class of sets is shown to play a crucial role. The bounds are illustrated on various examples.

Keywords : hypothesis testing, multiple hypotheses, Gaussian processes

AMS Classification Numbers : 62F03, 62F05

11:00 - 11:30 **Coffee Break**

11:30 - 13:15 **Invited Session: Mathematical Finance** *Venue: SSIU seminar hall*
(*Chair: Gopal K Basak, Indian Statistical Institute, Kolkata*)

11:30 **Hoi Ying Wong**, *The Chinese University of Hong Kong*
Mean-variance portfolio and asset-liability management when assets are co-integrated

Co-integration of major financial markets around the globe is well evidenced with strong empirical support. Nowadays, it becomes indispensable for financial companies, which participate in the international financial markets, to manage their assets and liabilities by taking into account the concept of co-integration. This paper considers the continuous-time mean-variance (MV) portfolio and asset-liability management (ALM) problems in an incomplete financial market with co-integrated assets. Therefore, the number of trading assets can be less than the number of Brownian motions spanning the market. By the celebrated Granger (1981) representation theorem, co-integrated time series should follow the error-correction model. We assume that the co-integration market follows the diffusion limit of the error-correction model derived by Duan and Pliska (2004). Using the Markowitz (1952) mean-variance portfolio criterion, we consider financial companies' problems of minimizing the variance of terminal wealth given an expected terminal wealth for the case of portfolio management and minimizing the variance of surplus given an expected surplus for the case of ALM. These two problems are collectively formulated as an MV portfolio problem with random parameters. The particular structure of co-integration enables us to completely solve the portfolio and ALM problems in the sense that solutions of the continuous-time portfolio policy and the efficient frontier are obtained as explicit and closed-form formulas. The key is the recognition of an affine form in the solution of a system of backward stochastic differential equations.

This is joint work with Mei Choi Chiu.

Keywords : co-integration, mean-variance portfolio theory, asset-liability management, random parameters

AMS Classification Numbers : 91G10, 91G80

12:05 **Freddy Delbaen**, *ETH, Zurich*
BSDE with unbounded terminal value

Using some à priori estimates, we will show that a BSDE with convex square bounded driver and terminal value having good exponential moments, has a unique solution in the same class.

This is joint work with Hu and Richou both from Université de Rennes.

Keywords : BSDE, unbounded terminal values, monetary utility function

AMS Classification Numbers : 91B16, 91B06, 91G80, 35H30, 49L25, 60H30

12:40 **K. Suresh Kumar**, *Indian Institute of Technology Bombay*
Stock models corresponding to modification in Black-Scholes formula

In this talk we study the effects of perturbation of the Black-Scholes formula in the stock price dynamics. As a result, we get a general functional from for the volatility of the stock.

Keywords : Black-Scholes formula, local voltility models, Feynmann-Kac representation

AMS Classification Numbers : 91B70

11:30 - 13:15 **Invited Session: SLE** *Venue: Auditorium (main)*
(*Chair: Manjunath Krishnapur, Indian Institute of Science*)

11:30 **Hugo Duminil-Copin**, *University of Geneva*
Self-avoiding walk on the hexagonal lattice

We will prove a conjecture made by B. Nienhuis regarding the connective constant of the hexagonal lattice. More precisely, we will show that the number a_n of self-avoiding walks of length n (starting at the origin) satisfies:

$$\lim_{n\to\infty} a_n^{\frac{1}{n}} = \sqrt{2+\sqrt{2}}.$$

The proof uses a parafermionic observable for the self avoiding walk, which satisfies a half of the discrete Cauchy-Riemann relations. Establishing the other half of the relations (which conjecturally holds in the scaling limit) would also imply convergence of the self- avoiding walk to SLE(8/3). This is a joint work with S. Smirnov.

Keywords : self-avoiding walks, conformal invariance, honeycomb lattice

AMS Classification Numbers : 60C05, 82C41

12:05 **Antti Kemppainen**, *University of Helsinki*
Random curves, scaling limits and Loewner evolutions

Random curves arise naturally as interfaces in the 2D statistical physics and its lattice models. A general strategy to prove the convergence of a random discrete curve, as the lattice mesh goes to zero, is first to establish precompactness of the law giving the existence of subsequential scaling limits and then to prove the uniqueness. In this talk, I will introduce a sufficient condition that guarantees the precompactness and also that the limits are Loewner evolutions, i.e. they correspond to continuous Loewner driving processes. This framework of estimates is applicable in almost all proofs aiming to establish that an interface converges to a Schramm-Loewner evolution (SLE). In principle, it can be applied beyond SLE.

This is joint work with Stanislav Smirnov, Université de Genève.

Keywords : random curve, scaling limit, Schramm-Loewner evolution, weak convergence, arms exponent

AMS Classification Numbers : 60J67, 82B20

12:40 **Pierre Nolin**, *Courant Institute, New York University*
Connection probabilities and RSW-type bounds for the two-dimensional FK Ising model

For two-dimensional independent percolation, Russo-Seymour-Welsh (RSW) bounds on crossing probabilities are an important a-priori indication of scale invariance, and they turned out to be instrumental to describe the phase transition. They are in particular a key tool to derive the so-called scaling relations, that link the critical exponents associated with the main macroscopic functions.

In this talk, we prove RSW-type uniform bounds on crossing probabilities for the FK Ising model at criticality, independent of the boundary conditions. A central tool in our proof is Smirnov's fermionic observable for the FK Ising model, that makes some harmonicity appear on the discrete level, providing precise estimates on boundary connection probabilities. We also prove several related results – including some new ones – among which the fact that there is no magnetization at criticality, tightness properties for the interfaces, and the value of the half-plane one-arm exponent.

This is joint work with H. Duminil-Copin and C. Hongler.

Keywords : Ising model, FK percolation, crossing probability, Russo-Seymour-Welsh

AMS Classification Numbers : 60K35, 82B20, 82B27

11:30 - 13:15 **Contributed Session:** *Venue: Auditorium (seminar hall)*
Stochastic Differential Equations
(*Chair: Giovanni Peccati, Luxembourg University*)

11:30 **Evelina Shamarova**, *University of Porto*
Solutions of the Navier-Stokes and Burgers equations via forward-backward SDEs

We establish a connection between the strong solution to the spatially periodic Navier-Stokes equations and a solution to a system of forward-backward stochastic differential equations (FBSDEs) on the group of volume-preserving diffeomorphisms of a flat torus. Assuming the existence of a solution to the Navier-Stokes equations with the initial data in the Sobolev space H^s for sufficiently large s, we construct a solution of the associated system of FBSDEs. Conversely, if we assume that a solution of the system of FBSDEs exists, then the solution of the Navier-Stokes equations can be obtained from the solution of the FBSDEs. In fact, the constructed FBSDEs on the group of volume-preserving diffeomorphisms can be regarded as an alternative characterization to the Navier-Stokes equations for studying the properties of the latter. On the other hand, we describe a probabilistic construction of H^s-regular solutions to the spatially periodic Burgers equation by proving the existence and uniqueness theorem for the associated forward-backward stochastic system. This work is joint with A. B. Cruzeiro.

References

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[2] A. B. Cruzeiro and E. Shamarova. On a forward-backward stochastic system associated to the Burgers equation, *Proceedings of the Workshop on Stochastic Analysis & Finance*, 2009.

Keywords : Navier-Stokes equations, forward-backward SDEs, Burgers equation, diffeomorphism group

AMS Classification Numbers : 65H10, 35Q30, 35Q53

12:05 **Lluís Quer-Sardanyons**, *Universitat Autònoma de Barcelona*
Weak convergence for the stochastic heat equation driven by Gaussian white noise

In many applications, even though the randomness acting on a certain system is neither white nor Gaussian, one usually justifies somehow that the noisy inputs can be approximated by a Gaussian white noise (see e.g. [2]). We illustrate this fact by considering the one-dimensional stochastic heat equation

$$\frac{\partial U_n}{\partial t}(t,x) - \frac{\partial^2 U_n}{\partial^2 x}(t,x) = b(U_n(t,x)) + \theta_n(t,x),\ \ (t,x) \in [0,T]\times[0,1] \tag{1}$$

with some initial condition and Dirichlet boundary conditions, where we assume that the family of processes θ_n have square-integrable paths and their integral processes converge to the Brownian sheet. We establish sufficient conditions on θ_n so that the mild solution of (1) converges in law, in the space of continuous functions $C([0,T]\times[0,1])$, to the mild solution of an analogous equation where $\theta_n(t,x)$ is formally replaced by the space-time white noise $\dot{W}(t,x)$. For this, we first make use of a suitable continuous functional of the stochastic convolution term in order to reduce the proof to the linear version of (1). Secondly, we prove that the corresponding family of laws is tight and we identify the limit law by showing the convergence of the finite dimensional distributions.

Moreover, we consider two particular families of noises θ_n to which our result applies. The first one involves a Poisson process in the plane and has been motivated by a one-dimensional result of Stroock ([1]), which states that the family of processes $n\int_0^t(-1)^{N(n^2s)}ds$, where N is a standard Poisson process, converges in law to a Brownian motion. The second one is constructed in terms of the kernels associated to the extension of Donsker's theorem to the plane.

This research work has been done in collaboration with Xavier Bardina and Maria Jolis (Universitat Autònoma de Barcelona).

References

[1] D.W. Stroock. Lectures on topics in stochastic differential equations. With notes by Satyajit Karmakar. *Tata Institute of Fundamental Research Lectures on Mathematics and Physics*, 68. Springer-Verlag, Berlin-New York, 1982.

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Keywords : stochastic heat equation, weak convergence, two-parameter Poisson process, Donsker kernels

AMS Classification Numbers : 60B12, 60H15

12:40 **Noèlia Viles**, *Universitat Autònoma de Barcelona*
Continuity in the Hurst parameter of the law of the Russo-Vallois symmetric integral

Consider the laws in $\mathcal{C}([0,T])$ of the family of fractional Brownian motions $\{B^H,\ H\in(0,1)\}$ with Hurst parameter $H\in(0,1)$. It is easily seen that these laws converge weakly to that of B^{H_0}, when H tends to $H_0\in(0,1)$.

It is interesting to study whether certain functionals of fractional Brownian motion conserve this property. That is, we ask if their law (in $\mathcal{C}([0,T])$) remains near to that of the corresponding functional for B^{H_0} when H is near to H_0. This kind of result justifies the use of $B^{\hat{H}}$ as a model in applied situations where the true value of the Hurst parameter is unknown and $\hat{H}$ is some estimation of it.

We prove the convergence in law, in the space of continuous functions $\mathcal{C}([0,T])$, of the Russo-Vallois symmetric integral of a non-adapted process with respect to the fractional Brownian motion with Hurst parameter $H>1/2$ to the Russo-Vallois symmetric integral with respect to the fractional Brownian motion with parameter H_0, when H tends to $H_0\in[1/2,1)$.

References

[1] M. Jolis and N. Viles, Continuity in the Hurst parameter of the law of the symmetric integral with respect to the fractional Brownian motion, *Preprint* (2010).

[2] F. Russo and P. Vallois, Forward, backward and symmetric stochastic integration, *Probab. Theory Related Fields*, no. 3, **97** (1993), 403–421.

Keywords : convergence in law, fractional Brownian motion, Russo-Vallois symmetric integral

AMS Classification Numbers : 60B12, 60J55, 60G15

13:15 – 14:30 **Lunch**

14:30 - 16:15 **Invited Session: Stochastic Networks** *Venue: SSIU seminar hall*
(*Chair: Kavita Ramanan, Brown University*)

14:30 **Shankar Bhamidi**, *University of North Carolina, Chapel Hill*
Flows, first passage percolation and random disorder in networks

Consider a connected network and suppose each edge in the network has a random positive edge weight. Understanding the structure and weight of the shortest path between nodes in the network is one of the most fundamental problems studied in modern probability theory and goes under the name *first passage percolation*. It arises as a fundamental building block in many interacting particle system models such as the spread of epidemics on networks. To a large extent such problems have been only studied in the context of the n-dimensional lattice.

In the modern context these problems take on an additional significance with the minimal weight measuring the cost of sending information while the number of edges on the optimal path (hopcount) representing the actual time for messages to get between vertices in the network. Given general models of random graphs with random edge costs, can one develop techniques to analyze asymptotics of functionals of interest which are robust to the model formulation?

The aim of this talk is to describe a heuristic based on continuous time branching processes which gives very easily, a wide array of asymptotic results for random network models in terms of the Malthusian rate of growth and the stable age distribution of associated branching process. These techniques allow us to solve not only first passage percolation problems rigorously but also understand functionals such as the degree distribution of shortest path trees, congestion across edges as well as asymptotics for "betweeness centrality" a concept of crucial interest in social networks, in terms of Cox processes and extreme value distributions. These techniques also allow one to solve models of "weak disorder" in the context of the stochastic mean field model of distance, a model of great interest in probabilistic combinatorial optimization.

Keywords : flows, weak disorder, first passage percolation, random graphs, stochastic mean field model of distance, continuous time branching processes

AMS Classification Numbers : 60C05, 05C80, 90B15

15:05 **Lea Popovic**, *Concordia University*
Diffusion approximations for multiscale reaction networks

Reaction networks in biological systems can involve population sizes with vastly differing abundances and interactions whose rates also vary over several orders of magnitude. This wide variation in number and rate yield phenomena that evolve on very different time-scales. These differing time-scales can be exploited to obtain simplifications of complex models. In order to produce a reduced network one can use stochastic averaging with respect to components whose relative change is faster and obtain a simplified system of equations for the evolution of the components whose relative change is slower. In order to assess the fluctuations of the reduced system, one has to take into account both intrinsic fluctuations as well as fluctuations around averaged quantities. We present an appropriate diffusion approximation for the reduced reaction network.

Keywords : reaction networks, stochastic averaging, diffusion approximation, Poisson equation

AMS Classification Numbers : 60F05, 60F10, 60F17

15:40 **Ayalvadi Ganesh**, *University of Bristol*
Decentralised load balancing in closed and open networks

We study the performance of random load resampling strategies in parallel server systems. Clients initially attach to an arbitrary server, but may switch server independently at random instants of time in an attempt to improve their service rate. Load resampling is particularly relevant in scenarios where clients cannot predict the load of a server before being actually attached to it. We derive tight estimates of the time it takes for a given resampling strategy to achieve a perfect balance of the load across servers in a closed system. We also study open systems where clients arrive according to a random process and leave upon service completion. In this scenario, we characterize the stability region of various resampling strategies, and derive approximate estimates of the sojourn time obtained by letting the number of servers grow large.

This is joint work with S. Lilienthal, D. Manjunath, A. Proutiere and F. Simatos.

Keywords : load balancing, randomised algorithms

AMS Classification Numbers : 60K25, 60K35, 68W15, 68W20

14:30 - 16:50 **Contributed Session: Interacting Particle Systems** *Venue: Auditorium (main)*
(*Chair: Maury Bramson, University of Minnesota*)

14:30 **Antar Bandyopadhyay**, *Indian Statistical Institute, Delhi*
On the expected total number of infections for virus spread on a finite network

In this work we consider a simple virus spread model on a finite population of n agents connected by some neighborhood structure. Let G be the graph on n agents where an infection starts with some initial number of infected sites. The infection spreads as follows: at each discrete time step, an infected vertex tries to infect its neighbors with probability $\beta \in (0,1)$ independently of others and then it dies out. The process continues till all infected sites dies out. We focus on obtaining proper lower bounds on the expected number of ever infected sites. We obtain a simple lower bound when the infection starts with only one individual using *breadth-first search* algorithm. We show that in a variety of examples this lower bound gives better approximation than some of the known approximations through matrix-method based upper bounds. Moreover the lower bound works for every value of $\beta \in (0,1)$. In fact, it is shown that if the graph G "*locally looks like a tree*" in the sense of the local weak convergence then our lower bound is asymptotically exact. Finally, we also provide a generalization of this bound when the virus spread starts with more than one infected agents.

This is joint work with Farkhondeh Sajadi.

Keywords : breadth-first search, local weak convergence, random graphs, spanning trees, virus spread

AMS Classification Numbers : 60K35, 05C80, 60J85, 90B15

15:05 **Partha Sarathi Dey**, *University of California, Berkeley*
Stein's method for concentration inequalities - extension and applications

Stein's method is a semi-classical tool for establishing distributional convergence in problems involving complex dependencies. A general way of deriving concentration inequalities using Stein's method was introduced by Sourav Chatterjee in his Ph.D. thesis. In this talk we present extension and some applications of Stein's method for concentration inequalities. We prove a concentration inequality for the magnetization in the Curie-Weiss model at critical temperature where it obeys a non-standard normalization and super-Gaussian concentration. We also show how this method can be used to derive exact large deviation asymptotics for the number of triangles in the Erdós-Rényi random graph $G(n,p)$ when $p \geq 0.31$. This talk is based on joint work with Sourav Chatterjee.

Keywords : Stein's method, concentration inequality, Curie-Weiss model, random graph, large deviation

AMS Classification Numbers : 60E15, 60F10

15:40 **Raazesh Sainudiin**, *University of Canterbury*
Exact transition probabilities of the number of ancestral sample lineages in the discrete ancestral recombination graph

We derive the exact one-step transition probabilities of the number of lineages that are ancestral to a random sample from the current generation of a population that is evolving under the discrete Wright-Fisher model [1, 2] for recombining haploid individuals [3, 4]. When we appropriately rescale time by the population size, our model leads to the continuous time Markov chain called the ancestral recombination graph of Griffiths

[4]. Explicit discrete time computations of these probabilities by counting appropriate bipartite graphs for a time-reversed, recombining, haploid, Wright-Fisher population are not available in the literature as most ARG models are typically formulated approximately in the continuous setting of large population limits [3, 4]. Our discrete ARG model provides a natural prior probability for statistical decision problems in conservation genetics of highly threatened populations.

This is joint work with Bhalchandra Thatte.

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Keywords : discrete recombination, coalescent approximation, bipartite graphs, conservation genetics

AMS Classification Numbers : 92D15, 92D20, 92D40, 05A18, 60J80, 60J85

16:15 **Rahul Roy**, *Indian Statistical Institute, Delhi*
Learning from neighbours

Consider a discrete time interacting particle system on the integer line where particles are of two types– red and blue. At each instance a particle tosses a coin and based on the success/failure of its own coin, as well as the colours and tosses of the neighbouring coins it decides whether to retain its colour or change to the other colour. We study the limiting behaviour of the resultant Markov chain. This model has been studied by economists to model diffusion of technologies. This is joint work with Antar Bandyopadhyay and Anish Sarkar.

Keywords : particle systems, Markov chain

AMS Classification Numbers : 60K35

14:30 - 16:15 **Contributed Session:** *Venue: Auditorium (seminar hall)*
Combinatorial Probability and Urn Models
(*Chair: Srinivasa Varadhan, Courant Institute, New York University*)

14:30 **Ghurumuruhan Ganesan**, *Indian Statistical Institute, Delhi*
Two properties of the random partition of an integer

In this paper, we consider two properties of integer partitions. It is well-known that there exists a one-to-one correspondence between partitions of the integer n and the Ferrer diagram containing n points. In the first part of our paper, we consider the number of ways a random Ferrer diagram containing n points can be dismantled. In general d dimensions, this problem arises, for example, while obtaining the upper bound for the quantity $\alpha_d = \limsup \frac{\ln p_d(n)}{n^{(d-1)/d}}$ where $p_d(n)$ is the number of $d-$ dimensional integer partitions of n. Using the fact that the number of planes needed to dismantle a $d-$dimensional Ferrer diagram is no more that $dn^{1/d}$, an upper bound on α_d is obtained. For 2D and 3D integer partitions, we prove that almost always no more than $(1.1)\sqrt{n}$ and $(2.1)n^{\frac{1}{3}}$ planes are respectively needed for dismantling a random Ferrer diagram. We think of the Ferrer diagram as a collection of planes (lines) along $X-$ and $Y-$ axis and also obtain asymptotic expressions for the minimum number of planes needed to dismantle in integer partition. We then extend the result to Plancherel distributed and 3D integer partitions.

In the second part of our paper, we prove a conjecture of Yakubovich regarding limit shapes of "slices" of 2D integer partitions of n when the number of summands $m \sim An^{\alpha}$. Doing so, we are also able to strengthen the following result due to Erd$\ddot{o}$s that concerns the relation between the number of integer partitions and compositions. It is well-known that if $p_m(n)$ and $\tilde{p}_m(n)$ denote the number of partitions and compositions, respectively, of an integer n into m summands, then, $p_m(n) \sim \tilde{p}_m(n)$ if $m = o(n^{\frac{1}{3}})$. As a corollary of our proof of the Yakubovich conjecture, we prove that $p_m(n) \sim \tilde{p}_m(n)$ if and only if $m = o(n^{\frac{1}{3}})$. Finally, we extend

Yakubovich's result on limit shapes of slices for the case of compositions for all values of multiplicities and all $0 < \alpha < 1$.

Keywords : dismantling Ferrer diagram, Yakubovich conjecture, random compositions

AMS Classification Numbers : 60C05

15:05 **Krishanu Maulik**, *Indian Statistical Institute, Kolkata*
Strong laws for balanced block triangular urns with irreducible diagonal blocks

We consider an urn model, whose replacement matrix is block upper triangular with irreducible diagonal blocks, has all entries nonnegative and constant row sums. We obtain strong laws, under mild conditions, for the counts of balls corresponding to each color. The analysis requires a rearrangement of the colors. We show that the scalings for these counts depend on the Perron-Frobenius eigenvalues of a related diagonal block identified through the rearrangement. We show that the limiting random variables corresponding to the counts of colors within a block are constant multiples of each other. We provide an easy-to-understand explicit formula for them as well, which involves the left eigenvector corresponding to the Perron-Frobenius eigenvalue of the diagonal block used in obtaining the scale.

This is a joint work with Amites Dasgupta.

Keywords : urn model, balanced triangular replacement matrix, Perron-Frobenius eigenvalue, irreducible matrix

AMS Classification Numbers : 60G70, 60F05

15:40 **Srinivasan Balaji**, *George Washington University*
Phases in the diffusion of gases via the Ehrenfest urn

The Ehrenfest urn is a model for the mixing of gases in two chambers. We study the gradual change for an urn containing n balls from the initial condition to the steady state. We look at the status of the urn after k_n draws. We identify three phases of k_n: The growing sub linear, the linear, and the superlinear. In the growing sublinear phase the amount of gas in either chamber is normally distributed, with parameters that are influenced by the initial conditions. In the linear phase a different normal distribution applies, in which the influence of the initial conditions is attenuated. The steady state is not a good approximation until a superlinear amount of time has elapsed. At the superlinear stage the mix is nearly perfect, with a nearly perfect symmetrical normal distribution in which the effect of the initial conditions is completely washed away. We give interpretations for how the results in different phases conjoin at the seam lines. The Gaussian results are obtained via martingale theory.

This work is jointly done with Hosam Mahmoud and Tong Zhang of George Washington University.

Keywords : urn model, random structure, martingale, central limit theorem

AMS Classification Numbers : 60C05, 60F05, 05A05, 60G42

16:15 – 17:00 Coffee Break

Monday, August 16, 2010

08:00 - 09:00 **Registration**

09:00 - 10:00 **Plenary Session** *Venue: Auditorium (main)*
(*Chair: Rahul Roy, Indian Statistical Institute, Delhi*)

Erwin Bolthausen, *University of Zurich*
Non-ballistic random walks in random environments

We report on a multiscale approach for the exit distributions of random walks in random environments, developed jointly with Ofer Zeitouni (University of Minneapolis, and Weizman Institute). The basic model is a random walk moving in an environment generated by independent identically chosen transition probabilities, whose distributions are invariant under lattice isometries. The original approach required the dimension to be at least three. We report also on more recent progress in dimension two, and about estimates for the Green's function.

Keywords : random walks, random environments

AMS Classification Numbers : 60K37

10:00 - 11:00 **Plenary Session** *Venue: Auditorium (main)*
(*Chair: Krishanu Maulik, Indian Statistical Institute, Kolkata*)

Alison Etheridge, *University of Oxford*
Modelling evolution in a spatial continuum

One of the outstanding successes of mathematical population genetics is Kingman's coalescent. This process provides a simple and elegant description of the genealogical trees relating individuals in a sample of neutral genes from a panmictic population, that is, one in which every individual is equally likely to mate with every other and all individuals experience the same conditions. But real populations are not like this. Spurred on by the recent flood of DNA sequence data, an enormous industry has developed that seeks to extend Kingman's coalescent to incorporate things like variable population size, natural selection and spatial and genetic structure. But a satisfactory approach to populations evolving in a spatial continuum has proved elusive. In recent joint work with Nick Barton, IST Austria, we introduced a framework for modelling the evolution of populations distributed in a spatial continuum. This leads to a new class of measure-valued processes which we will describe and, as time permits, explore in this talk.

Keywords : spatial Lambda-Fleming-Viot processes, coalescent models, population modelling, spatial continuum

AMS Classification Numbers : 60J25, 60J70, 92D10, 92D15

11:00 - 11:30 **Coffee Break**

11:30 - 13:15 **Invited Session: Rough Path Analysis** *Venue: SSIU seminar hall*
(*Chair: Samy Tindel, University of Nancy*)

11:30 **Peter Friz**, *TU-Berlin and WIAS*
A (rough) pathwise approach to SPDEs

We present a (rough)pathwise view on stochastic partial differential equations; examples range from the (fully non-linear) stochastic HJB equation (introduced by Lions-Souganidis) to the (generalized) Zakai equation arising from non-linear filtering (with correlation). Our results are based on the marriage of rough path analysis with (2nd order) viscosity theory.

This is joint work with M. Caruana and H. Oberhauser.

Keywords : rough paths, viscosity theory, SPDEs

AMS Classification Numbers : 35K55, 60H15

12:05 **Yuzuru Inahama**, *Nagoya University*
Laplace-type asymptotics in the rough path theory

In this talk we discuss Laplace-type asymptotic theorem for "small noise limit" of rough differential equations driven by (1) fractional Brownian motion with Hurst parameter between 1/4 and 1/2 and (2) infinite dimensional Brownian motion. This type of problems has a long history. It was initiated by Azencott in 1982 for SDEs in the usual sense which is driven by finite dimensional Brownian motion. The key of the proof is the Taylor expansion of the Itô map in the rough sense around the point at which the minimum is achieved.

Keywords : rough path, Laplace approximation, large deviation, fractional Brownian motion

AMS Classification Numbers : 60F99, 60H10, 60G22

12:40 **Samy Tindel**, *University of Nancy*
Rough paths and Skorohod stochastic calculus for Gaussian processes

I will discuss some recent developments on rough path constructions for Gaussian processes with low regularity, typically below the usual threshold of a Hölder exponent $\gamma = 1/4$. In spite of the fact that the iterated integrals built up in this case cannot be considered as canonical, I will show that they give raise to reasonable change of variable formulas, both in the Stratonovich and Skorohod sense. The method combines rough paths considerations and Wick type calculus.

This talk is based on an ongoing work with Yaozhong Hu (Kansas) and Maria Jolis (Barcelona).

Keywords : rough paths analysis, Wick products, Malliavin calculus

AMS Classification Numbers : 60H07, 60H40, 60H05

11:30 - 13:15 Invited Session: Polymer Models *Venue: Auditorium (main)*
(*Chair: Anish Sarkar, Indian Statistical Institute, Delhi*)

11:30 **Hubert Lacoin**, *Universita di Roma Tre*
Directed polymers in random environment: Influence of disorder and the superdiffusivity phenomenon

Directed polymers in random environment is a model to describe the behavior of polymer chain in a medium with hetegeroneous impurities. The polymer configuration is modelized as directed random walk of N (N meant to be a large integer) steps in $\mathbb{Z}^d$ whose probability law is modified by random Gibbs weights. In high dimension, this model exhibits a phase transition from a low-temperature phase where disorder localizes the polymer along corridor of favorable environment to an high-temperature phase, where the polymer configuration keeps all the characteristic features of the simple random walk (in particular: the invariance principle). The aim of this talk is to give an overview of the model, explaining the crucial role played by the analysis of the partition function, characterising the strong/weak disorder phase and giving an overview of recent superdiffusivity results.

Keywords : directed polymers, random media, superdiffusivity

AMS Classification Numbers : 82D60, 60K37, 82B44

12:05 **Xia Chen**, *University of Tennessee*
Brownian motion in a renormalized Poissonian potential

The model of Brownian motion in Poissonian potential describes a typical trajectory of a Brownian particle surviving from being attracted by the obstacles randomly located in the space (think about the stars in the universe). In the existing literature, the random potential is defined as the convolution between a Poissonian field and a bounded and locally supported function.

According to the Newton's law of universal attraction and some other related laws in physics, the most natural way of constructing the random potential is to define it as the Riesz potential of the Poissonian field. On the other hand, the Riesz potential of the Poissonian field blows up.

In this talk, this problem will be fixed by the way of renormalization. In addition, some asymptotic patterns of our models will be established and more problems will be asked.

Part of the talk is based on some collaborative works with Kulic and Rosen.

Keywords : Brownian motion, Poissonian potential, Brownian potential

AMS Classification Numbers : 60K40, 60J45

12:40 **Rongfeng Sun**, *National University of Singapore*
Random walk among moving Poissonian traps

We review some old and new results on the survival probability of a random walk among a Poisson field of moving traps on $\mathbb{Z}^d$, which can also be interpreted as the solution of a parabolic Anderson model with a random time-dependent potential. We show that the annealed survival probability decays asymptotically as $\exp(-\sqrt{8t/\pi})$ for $d = 1$, as $\exp(-\pi t/\log t)$ for $d = 2$, and as $\exp(-c_d t)$ for some $c_d > 0$ for $d \geq 3$, while the quenched survival probability always decays exponentially.

This talk is based on a survey article jointly with A. Drewitz, J. Gärtner, and A. F. Ramírez.

Keywords : Poissonian traps, parabolic Anderson model, directed polymer

AMS Classification Numbers : 60K35, 60K37

11:30 - 13:15 **Contributed Session: Diffusions and Related Models** *Venue: Auditorium (seminar hall)*
(*Chair: Alison Etheridge, University of Oxford*)

11:30 **Vivek Shripad Borkar**, *Tata Institute of Fundamental Research*
Small noise limits and Feller selection

A new selection principle is proposed for construction of a Feller solution to an ill-posed degenerate diffusion process. This is based on constructing the Feller transition kernel from the unique (under suitable conditions) continuous viscosity solutions to the backward Kolmogorov equation associated with the diffusion. The connections of this Feller process with the small-noise limits of nondegenerate perturbations of the diffusion and several other related phenomena are also discussed. (Joint work with K. Suresh Kumar, Indian Institute of Technology, Mumbai.)

Keywords : degenerate diffusions, Feller selection, small noise limit, viscosity solutions

AMS Classification Numbers : 60H10, 60J25, 34F05, 35K65

12:05 **Krishnamurthi Ravishankar**, *SUNY-New Paltz*
Marking the Brownain web and applications

In this talk I will discuss recent results (and some ongoing work) obtained in collaboration with C.M. Newman and E. Schertzer. I will start with a brief introduction to the discrete web of coalescing simple random walks and its continuum diffusive limit, the Brownian web (BW). After indicating how the continuum limit of the noisy voter model (Glauber dynamics of nonzero temperature stochastic Ising model) is obtained using the marking of $(0, 2)$ (or bulk nucleation) points of the BW, the remainder of the talk will focus on $(1, 2)$ points of the BW which correspond to the boundary nucleation points of the stochastic Potts model. I will then de- scribe the marking procedure for the $(1, 2)$ points and indicate how it can be used to construct the Brownian net and then I will describe how these marking(along with the markings of $(0, 2)$ points) can be used obtain the continuum limit of stochastic Potts model. If time permits I will discuss the marking construction of dynamical Brownian web.

Keywords : coalescing random walks, Brownian web, Brownian net, Ising and Potts models, continuum limits

AMS Classification Numbers : 60K35, 60K35, 60F17

12:40 **Siva Athreya**, *Indian Statistical Institute, Bangalore*
Brownian motion on R trees

The real trees form a class of metric spaces that extends the class of trees with edge lengths by allowing behavior such as infinite total edge length and vertices with infinite branching degree. We use Dirichlet form methods to construct Brownian motion on a given locally compact $\mathbb{R}$-tree equipped with a Radon measure ν. We then characterize recurrence versus transience.

This is joint work with Anita Winter

Keywords : Brownian motion, $\mathbb{R}$-trees

AMS Classification Numbers : 60J25, 60J75, 92B10

13:15 – 14:30 Lunch

14:30 - 16:15 Invited Session: Random Matrices *Venue: Auditorium (main)*
(*Chair: Arup Bose, Indian Statistical Institute, Kolkata*)

14:30 **Steven J Miller**, *Williams College*
Eigenvalue statistics for Toeplitz ensembles

Random Matrix Theory was developed by physicists to model the energy levels of heavy nuclei. We discuss some of the classical results, and consider some 'thin' ensembles of real symmetric Toeplitz matrices. Such matrices have far fewer degrees of freedom than the ensemble of all real symmetric matrices, and new behavior is seen: the density of eigenvalues of normalized real symmetric matrices is a semi-circle; real symmetric Toeplitz matrices is almost Gaussian. The deviations can be interpreted in terms of obstructions to Diophantine equations. The obstructions vanish if we consider real symmetric palindromic Toeplitz matrices, in which case the limiting spectral measure is a Gaussian. Using the method of moments and an analysis of the resulting Diophantine equations and combinatorics, we show that the spectral measures converge almost surely. We end with some results on what happens when we increase the palindromicity of the ensemble, in particular proving this new ensemble has the fattest tails of any limiting measure observed to date.

Keywords : random matrix theory, Toeplitz ensembles

AMS Classification Numbers : 15B52, 60F05, 11D45

15:05 **Manjunath Krishnapur**, *Indian Institute of Science*
Limit of characteristic polynomials of a random matrix

We show that the characteristic polynomials of $n \times n$ Gaussian matrices, normalized by a random constant, converges to a random analytic function. We show that the limit random analytic function is a mixture of Gaussian analytic functions. The main feature of the proof is a version of Pólya's urn scheme for Hilbert space valued random variables.

This is joint work with Blint Virág.

Keywords : random matrix, random analytic function, gaussian analytic function

AMS Classification Numbers : 60B20, 30B20

15:40 **Wenbo Li**, *University of Delaware*
Probabilities of all real zeros for random polynomials

There is a long history on the study of zeros of a random polynomial whose coefficients are independent, identically distributed, non-degenerate random variables. We will provide exact and/or asymptotic bounds on probabilities that a random polynomial under various distributions has all real zeros.

Keywords : random polynomials, probability estimates

AMS Classification Numbers : 60E05, 60G07, 60K40

14:30 - 16:15 Contributed Session: *Venue: Auditorium (seminar hall)*
Markov Models and Related Topics
(*Chair: Louis Chen, National University of Singapore*)

14:30 **Tamal Banerjee**, *Indian Institute of Science*
Pricing of defaultable bonds in a Markov modulated market

We address the problem of pricing defaultable bonds in a Markov modulated market. Using Merton's structural approach we show that various types of defaultable bonds are European type contingent claims. Thus pricing a defaultable bond is tantamount to pricing a contingent claim in a Markov modulated market. Since the market is incomplete we use the method of quadratic hedging and minimal martingale measure to derive locally risk minimizing derivative prices, hedging strategies and the corresponding residual risks. By numerically solving the appropriate PDEs with suitable boundary conditions we carry out an extensive numerical investigation of defaultable bond prices and compare the credit spreads with some of the existing models.

Keywords : defaultable bond price, quadratic hedging, minimal martingale measures, credit spread

AMS Classification Numbers : 91B28, 91B70

15:05 **Biswaroop Mookherjee**, *BASES The Nielsen Company*
Markov chains with random transition probability matrix

A Markov Chain $\{S_t, t = 0, 1, \ldots\}$ with m discrete states in discrete time has Random Transition Probability Matrix (TPM) T of order $m \times m$. T can assume any of the matrices $\{T_1, T_2, \ldots T_k\}$ at a particular time. The occurrence of T_i as TPM at time t depends only on what TPM was there at time $t-1$. There is one more Markov Chain $\{M_t, t = 0, 1 \ldots\}$ of these TPM's i.e. the state-space of M_t is $\{T_1, T_2, \ldots T_k\}$. The TPM of M_t is R of order $k \times k$.

In this paper we have studied limiting probabilities of the n-step TPM of S_t i.e. T^n under different situations and also we have found estimators of the parameters i.e. the elements of the matrices $T_1, T_2, \ldots, T_k$ and R. We have first considered when M_t is observable and then also when M_t is hidden.

Let a_{sij} denotes the element at ith row and jth column of the TPM T_s. Evidently,

$$\sum_{j=1}^{m} a_{sij} = 1,$$

for $s = 1, \ldots, k$ and $i = 1, \ldots, m$. An important result we have found is that the n-step TPM T^n converges as $n \to \infty$ if

$$\frac{a_{sij}}{\sum_{i,j=1}^{m} a_{sij}} = \frac{a_{rij}}{\sum_{i,j=1}^{m} a_{rij}},$$

for all s, r, i, j.

Hence, the limiting probabilities depend on how transition probabilities of not being in the same state in the matrix T change. We have shown application of the phenomena of this paper in agriculture and finance.

The first example taken is of a Markov Chain with two states denoting increase and decrease of salinity of soil where the TPM is a random matrix and the probable matrices depend on a different Markov Chain i.e. of rainfall. Here the states of both of the Markov Chains are observable. The other example taken is of a Markov Chain with two states denoting increase and decrease of price of a stock where the TPM is a random matrix and the probable matrices depend on a different Markov Chain i.e. of existence of bearish or bullish attitude among investors. Here the price of the stock is observable but existence of bearish and bullish attitude is not.

Keywords : Markov chains, random matrices, limiting probabilities, estimation

AMS Classification Numbers : 60J10, 60B20, 62M05

15:40 **Subhamay Saha**, *Indian Institute of Science*
Generalised semi-Markov processes

A semi-Markov process is completely determined by the holding time distributions in each state and the transition probabilities of the embedded Markov chain. In this work we construct a generalized semi-Markov process on a countable state space where the transition probabilities are age-dependent. Under certain condition we establish the Feller property of the process. Finally we compute the limiting distribution of the process.

This is joint work with Mrinal Ghosh.

Keywords : transition rate function, Feller property, semi-Markov process, limiting distribution

AMS Classification Numbers : 60J27, 60J75

14:30 - 16:15 **Contributed Session: Statistics and Simulations** *Venue: Auditorium (smu)*
(*Chair: K. Suresh Kumar, Indian Institute of Technology Bombay*)

14:30 **Rahul Jain**, *University of Southern California*
Solving Markov decision problems via simulations

It is well-known that solving Markov decision processes using dynamic programming is computationally intractable. We propose a simulation-based framework that exploits the uniform laws of large numbers developed by Vapnik-Chervonenkis, and others. The Vapnik-Chervonenkis theory is a generalization of the classical Glivenko-Cantelli theorem. They obtained necessary and sufficient conditions for a uniform law of large numbers to hold for a class of measurable Boolean functions. This was later extended to bounded real-valued functions by Pollard and others. It was shown that the rate of convergence depends on the epsilon-covering number of the function class introduced by Kolmogorov and Tihomirov.

We present the beginnings of a corresponding empirical process theory for Markov decision processes. We provide uniform law of large number results for particular functionals of Markov decision processes. When uniform convergence is obtained, we also obtain the rate of convergence in terms of P-dimension of the policy class. Surprisingly, we find that how sample tra jectories of a Markov process are obtained from simulation matters for uniform convergence: There are good simulation models (for which one may get uniform convergence) and bad simulation models (for which one may not get uniform convergence for the same set of Markov processes). This phenomenon seems to be the first such observation in the theory of empirical processes. Uniform convergence results are also obtained for the average reward case, for some partially observed processes, and for Markov games.

We then introduce a simulation-based framework for optimization of Markov decision processes. In particular, we give an simulation-based algorithm to compute epsilon-optimal policy and show the regret minimization property of such a framework. We then show its application to a class of Multi-armed bandit problems.

Keywords : Markov decision processes, simulation methods, empirical process theory

AMS Classification Numbers : 90, 90C40

15:05 **Ananya Lahiri**, *Indian Institute of Technology Kanpur*
Estimating the parameters of multiple chirp signals

Chirp signals occur quite naturally in different areas of signal processing. In this article, we consider the estimation procedures of the different parameters of multiple chirp signals. Using the orthogonal structure of the different components, we propose a sequential estimation procedure of the different parameters step by step. It reduces to solve only a two dimensional optimization problem at a time. It is observed that the proposed method produces the estimators which are asymptotically equivalent to the least squares estimators. We perform some simulation experiments, to observe how the asymptotic results behave for small sample sizes, and the performances are quite satisfactory. One data set has been analyzed for illustrative purposes.

Keywords : chirp signals, least squares estimators, strong consistency, asymptotic distribution, linear processes.

AMS Classification Numbers : 62M99

15:40 **Sandeep Juneja**, *Tata Institute of Fundamental Research*
A large deviations perspective on efficiency of simulation estimators

Consider a simulation estimator $\alpha(c)$ based on expending c units of computer time to estimate a quantity α. One measure of (lack of) efficiency is the magnitude of the probability of making an error of (at least) ϵ for a given (but large) computer budget c, namely $P(|\alpha(c) - \alpha| > \epsilon)$. We establish, in substantial generality, a large deviations result that asserts that this probability decays roughly exponentially in the budget c. As a consequence, this point of view leads to a preference for one estimator over another if its associated exponential decay rate constant is the larger of the two. The decay rate depends critically on both the distribution of the estimator itself and that of the random amount of computer time required to generate the estimator. Consequently, large deviations analysis of simulation-based estimators that fail to account for the distribution of the random time required to generate a sample may be misleading. This paper also develops an exact asymptotic for the error probability in the important setting in which the estimator is constructed as an average of independent and identically distributed samples. Our analysis also establishes that non-convex rate functions can arise in this context. The principal results in this paper can be viewed as large deviations analogs to classical measures of simulation efficiency going back to Hammersley and Handscomb.

This is a joint work with Peter Glynn, Department of Management Science and Engineering, Stanford University, USA.

Keywords : large deviations, simulations, efficiency

AMS Classification Numbers : 60F10, 65C05

14:30 - 16:15 **Contributed Session:** *Venue: SSIU seminar hall*
Information Theory and Free Probability
(*Chair: Alain-Sol Sznitman, ETH, Zurich*)

14:30 **Mokshay Madiman**, *Yale University*
Concentration of information content for log-concave probability measures

Suppose a random vector $X = X^{(n)}$ taking values in $\mathbb{R}^n$ has a density f. The random variable

$$\widetilde{h}(X) = -\log f(X)$$

may be thought of as the (random) information content of X. The entropy of X is defined by $h(X) = -\int f(x)\log f(x)\,dx = E\widetilde{h}(X)$, when it exists.

Because of the relevance of the information content in various areas such as information theory, probability, and statistics, it is intrinsically interesting to understand its behavior. In particular: Is it true that the information content concentrates around the entropy in high dimension? This is clearly true when $X = (X_1, \ldots, X_n)$ has i.i.d. components; indeed, in that case, one also has that $-\frac{1}{n}\log f(X^{(n)}) \to h(X_1)$ almost surely, by the law of large numbers, which is the simplest instance of the Shannon-McMillan-Breiman theorem for stationary, ergodic processes.

In general, there is no reason for such a concentration property to hold. Our main purpose is to show, however, that when the probability measure on $\mathbb{R}^n$ of interest is absolutely continuous and log-concave, $\log f(X)$ does possess a powerful concentration property. Specifically, *if $X = (X_1, \ldots, X_n)$ is distributed according to a log-concave density f on $\mathbb{R}^n$, then*

$$Pr\Big\{ \big|\widetilde{h}(X) - h(X)\big| \geq t\sqrt{n} \Big\} \leq 2\,e^{-ct},$$

for all $t > 0$, where $c \geq 1/16$ is a universal constant.

The result is also closely tied to the Shannon-McMillan-Breiman theorem [cf. Barron (1985) and Orey (1985) for stationary, ergodic processes]. These works imply that if $\mathbb{X} = (X_1, X_2, \ldots)$ is a stationary and ergodic process, and $X^{(n)} = (X_1, \ldots, X_n)$, then, as $n \to \infty$,

$$-\frac{1}{n}\log f(X^{(n)}) \to h(\mathbb{X}), \quad \text{a.s.}$$

where the "entropy rate" $h(\mathbb{X})$ is defined by

$$h(\mathbb{X}) := \lim_{n\to\infty} \frac{1}{n} h(X^{(n)}).$$

The aforementioned concentration property immediately yields the following extension of the Shannon-McMillan-Breiman phenomenon (without a stationarity assumption): *Suppose that $\mathbb{X}$ has a log-concave distribution on $\mathbb{R}^\infty$ with absolutely continuous finite dimensional projections. If the limit $h(\mathbb{X})$ exists, then $-\frac{1}{n}\log f(X^{(n)}) \to h(\mathbb{X})$ almost surely.* This is joint work with Sergey Bobkov at University of Minnesota.

Keywords : *Keywords:* concentration, entropy, log-concave, Shannon-McMillan-Breiman theorem

AMS Classification Numbers : *AMS Classification Numbers*: 60G07, 94A15

15:05 **Rajat Subhra Hazra**, *Indian Statistical Institute, Kolkata*
Subexponentiality of free regularly varying random variables

In this talk we consider $\{X_i\}_{1\leq i\leq n}$ to be free, identically distributed random variables affiliated to some W^*

probability space with law having a regularly varying tail. We study the tail behaviour of the partial sums and show that it is tail equivalent to its free maximum (in the sense of Ben Arous and Voiculescu (2006)). In particular, we study the behavior of the remainder term in the expansion of Cauchy transform and Voiculescu transform when the law has a regularly varying tail. The results also help us conclude that if additionally the law is infinitely divisible then its free Lévy measure is regularly varying and the two laws are tail equivalent.

This is joint work with Krishanu Maulik.

Keywords : free probability, Cauchy transform, Voiculescu transform, regular variation

AMS Classification Numbers : 46L54, 60G70

16:15 – 17:00 Coffee Break

Tuesday, August 17, 2010

08:00 - 09:00 **Registration**

09:00 - 10:00 **Plenary Session** *Venue: Auditorium Main*
(*Chair: Mrinal Kanti Ghosh, Indian Institute of Science*)

Louis Chen, *National University of Singapore*
Normal approximation by Stein's method

I will begin with Stein's original ideas and discuss applications to local dependence, moderate deviations, discretized normal approximation and multivariate normal approximation. If time permits, I will touch on applications to algebraic combinatorics and connection to the Malliavin calculus. This talk is based on material taken from a book which I am writing jointly with Larry Goldstein and Qi-Man Shao.

Keywords : Stein's method, normal approximation, moderate deviations, Malliavin calculus

AMS Classification Numbers : 60F05, 60F10, 60F17

10:00 - 11:00 **Plenary Session** *Venue: Auditorium Main*
(*Chair: Vivek Shripad Borkar, Tata Institute of Fundamental Research*)

Srinivasa Varadhan, *Courant Institute, New York University*
Central limit theorems for dependent random variables

Martingale approximations have proved to be a very powerful method for establishing central limit theorems for sums of dependent random variables under different mixing conditions. We will review them and describe some modifications that enable to treat sums of the form

$$\frac{1}{\sqrt{n}}\sum_{i=1}^{n} f(X_i, X_{2i}, \ldots, X_{ki})$$

under suitable mixing conditions.

Keywords : central limit theorem, mixing

AMS Classification Numbers : 60F05, 60F17

11:00 - 11:30 **Coffee Break**

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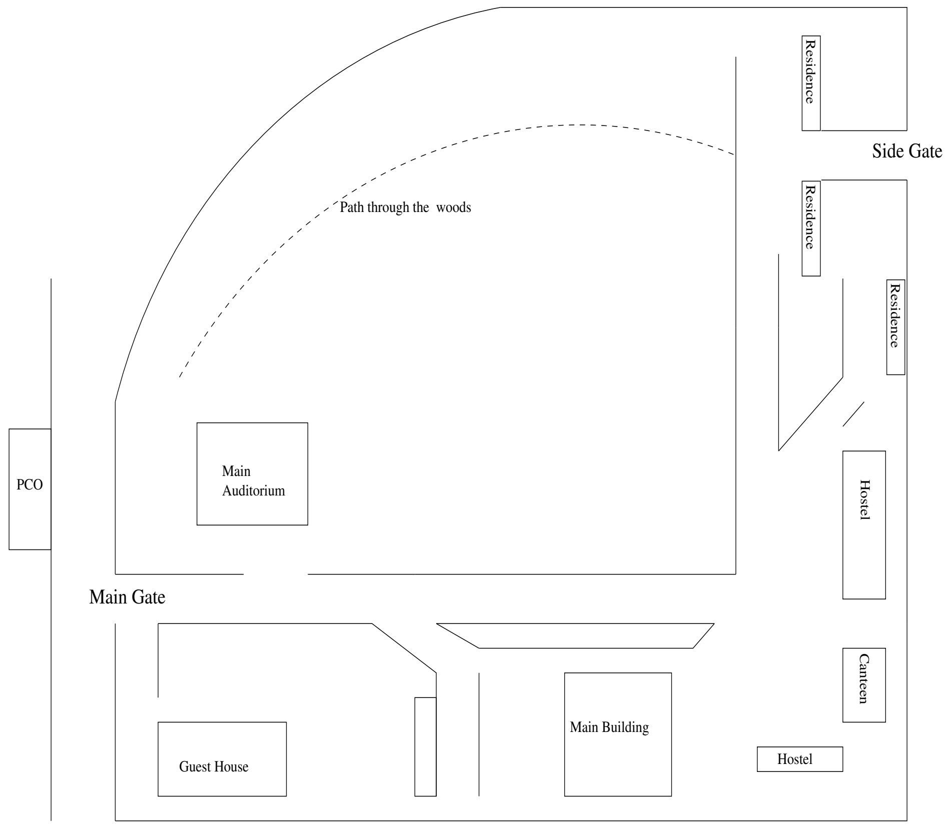
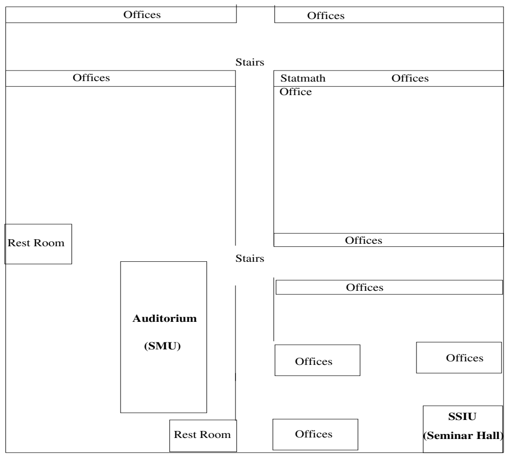
Schematic Map of the Indian Statistical Institute, Bangalore Centre
(Not to Scale)



Schematic Map of Second Floor of Main Building
(Not to Scale)



General Information

Talks: Plenary lectures will be held in the main auditorium. Invited and Contributed Sessions will be held in one of four venues (as indicated in the program): Auditorium (main), Auditorium (seminar), SSIU Seminar hall and Auditorium (smu). The Auditorium(main) and Auditorium (seminar) are located in the main auditorium and the SSIU Seminar hall and Auditorium (smu) are located in the second floor of the Main Building. (See Map.)

Registration Desk: It will be in the foyer of the main auditorium. This desk will also serve as an information desk for general queries and distribution of announcements.

Onsite Registration: Participants who have arranged to pay for congress registration by cash should do so at the Registration Desk.

Meals: Breakfast and dinner will be served in the institute canteen. The food for tea/coffee breaks, lunches and welcome reception (13th evening), will be served in the main auditorium. If you have any dietary restrictions then please contact the registration desk.

Emergency Contact numbers: Siva Athreya – 98862 93244, Statmath office – (within campus) 440, 28482724, and Security officer – (within campus) 502, 9741874390.

Medical Emergency: In case of a medical emergency please contact one of the numbers mentioned above. For general consultation, a doctor visits the campus between 2-4pm on weekdays. The nearest hospital is Sahana Hospital, Kengeri Satellite Town, Kengeri. Telephone: 28482806 / 28485806

Getting to Airport from Conference Venue: The easiest way to the airport is to hire a taxi. There are several taxi-service providers in Bangalore. The two main ones that provide service on meter to the airport are MERU Cabs (44224422) or Easy Cabs (43434343).

Getting to Train Station from Conference Venue: The easiest way to get to the train station is to take 222A bus from the stop on Mysore road. You can also hire a taxi from Spot Taxi Service (4110 0000) or City Safari (23225522, 23238899).

Transportation for local trips: There is a bus stop on Mysore road next to the Institute and the name of the stop is called Jayaram Das. If you wish to hire a taxi then you can do so from Aries cabs (26606744) or San Travels (9880712267) or Spot Taxi Service (4110 0000) or City Safari (23225522, 23238899). You may contact the registration desk for further assistance.

Computing Facilities: Our computer centre has Linux PCs and WINDOWS-Vista enabled PCs. The computer centre will remain open on 13th, 16th and 17th from 09:00 Hrs. to 17:30 Hrs. It is located on the first floor of the main building. The institute guest house, auditorium and the main building are WiFi enabled. You can connect your laptop to the network with the network key *ISIbc*.

Daily Announcements and Program Changes: An information sheet containing last minute announcements, program changes and other information would be available at the Registration desk and would be posted on the notice board.

Library: The institute's library is located in the ground floor of the main building. The opening hours are from 9:30am to 5:30pm.

Telephone: A couple of **Public Call Operators** (PCO) phone stands are in front of our institute's main gate. Local, interstate and international calls can be made on a payment basis. (See map for location.)

Bank Services and Foreign Exchange: There are several ATM's in the vicinity of the Institute. Sadly, not within walking distance. For exact location of one you may contact the registration desk. We have arranged for a money exchange agency to be present at the conference venue on the first and the fourth day of the meeting from 11am to 3pm.

Social Events

Sign up sheet: Other than the welcome reception you will need to sign up for the events. You can do so online or on sign up sheets at the registration desk.

Welcome Reception : *August 13th 2010*
There will be a welcome reception from 16:30 to 18:00 at the main auditorium. Soft drinks, Tea, Coffee, variety of finger foods, cakes and north Indian chat items will be served.

Traditional South Indian Dinner: *August 15th 2010*
This will be held a the main canteen of the institute from 20:00. This traditional south-Indian meal will be served to you on a banana leaf and will be a vegetarian affair.

The Green Heritage Walk in Lalbagh : *August 15th 2010*
This is a nature walk at Lalbagh Gardens, The walk starts at 07:00 and end with breakfast at 10:30. (See *http://www.bangalorewalks.com* for more details)

Bangalore through the ages Bus Tour : *August 15th 2010*
This is a four-hour city tour on a bus with several short stops. It is not a typica sightseeing tour, but a themed tour that covers elements of all Bangalore walks: traditional, colonial, green and contemporary (see *http://www.bangalorewalks.com* for more details).

Trip to Belur-Halebidu: *August 15th 2010*

Belur and Halibed are two small towns in Hassan district of Karnataka. You to visit the Hoysala temples built in the 12th century (See *http://www.karnataka.com/tourism/halebidu* for more details). The trip will start at 6:30am and end at 6pm. The journey from Bangalore to Belur and Halibed will take about 3 hours.

Conference Dinner: *August 16th 2010*

This will be held at the restaurant Sunny's from 19:00pm to 21:00pm. The restaurant is located on Vittal Mallya road, near UB city next to the Shell petrol station.

Tree Planting: August 17th 2010

We shall organise a tree planting event on campus, after the plenary talks. Sapling will be procured from the Forest department and pits shall be kept ready at appropriate places in the campus woods.

Lectures in Probability and Stochastic Process Series V

December 23-27, 2010

Indian Statistical Institute, Bangalore

Speakers:

1. **Krishanu Maulik,** *Indian Statistical Institute, Kolkata*
   Heavy Tailed Distributions

2. **S. R. S. Varadhan,** *Courant Institute, New York University*
   Schramm Loewner Evolution

Schedule: Each speaker will give eight 50 minute lectures and there will be additional discussion/open problem sessions. Please visit *http://www.isid.ac.in/∼antar/LPS* for more details.

History: Lectures on Probability and Stochastic Processes is an annual event conducted by the Theoretical Statistics and Mathematics Division of the Indian Statistical Institute. It started in November 2006 with the collective goodwill and interest of the probabilists working in India. Since then the workshop has been generously funded by the Indian Statistical Institute and National Board of Higher Mathematics. The workshop is designed to expose the researchers to some active areas of current interest in probability and stochastic processes. The workshop mainly consists of two mini courses given by two speakers who are experts in the respective topics. The idea is to expose the participants in some of the current active areas in probability and stochastic processes and also to make them aware of the tools to work in those topics. Enough time is kept for the participants to interact among each other and also to give informal presentations. It is expected that this gathering will initiate collaborative work across different research centres of India

If you are interested in participating in this workshop please contact any one of the organizers:

1. Siva Athreya, Indian Statistical Institute, Bangalore
   E-Mail: athreya@isibang. ac.in

2. Antar Bandyopadhyay, Indian Statistical Institute, Delhi
   E-Mail: antar@isid.ac.in

3. Krishanu Maulik, Indian Statistical Institute, Kolkata
   E-Mail: krishanu@isical.ac.in

Please visit http://www.isid.ac.in/∼antar/Conferences/LPS/index.html for more details.