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Activity Report

July 1, 2001 – June 30, 2002

Mathematical Statistics

Department of Mathematics

Royal Institute of Technology

SE-100 44 Stockholm, Sweden

1. Personnel

Professors:	**Lars Holst,** FD. Main research areas: Combinatorial probability theory, limit theorems and approximations in probability, stochastic modelling.
	Boualem Djehiche, FD. Main research areas: Stochastic analysis, mathematical epidemiology, risk theory. (Professor from December 3, 2001.)
Associate professor: (Biträdande professor)	**Jan Grandell,** FD. Main research areas: Point processes and risk theory.
Associate professor: (Universitetslektor, docent)	**Harald Lang,** FD.
Senior lecturers: (Universitetslektorer)	**Jan Enger,** FD. **Gunnar Englund,** TeknD. **Johan Irbäck,** FL.
Researcher: (Forskarassistent)	**Torkel Erhardsson,** TeknD. Main research areas: Rare events in stochastic processes, probability approximations with error bounds.
Senior tutors: (Universitetsadjunkter)	**Gunnar Karlsson,** civiling. **Göran Rundqvist,** FK.
Senior tutor: (Forskningsingenjör)	**Björn-Olof Skytt,** civiling.
Graduate students:	**Fredrik Armerin,** civiling. **Anna Carlsund,** FL. **Per Hallberg,** civiling. **Henrik Hult,** TeknL.

2. Research

(See the home page of the Division of Mathematical Statistics: http://www.math.kth.se/matstat/matstat.html.)

2.1. Fractional stochastic partial differential equations

Research leader
Boualem Djehiche.

Scientist
Henrik Hult.

Keywords
Fractional Brownian motion, long-range dependence, stable processes.

Project description
This project addresses the problem of existence, uniqueness and regularity of solutions to stochastic partial differential equations driven by fractional white noise and fraction differential operators responsible for the spatial motion. These solutions arise as high density limits of particle systems with long-range dependence.

2.2. Dependence in multivariate dynamic stochastic models

Research leader
Boualem Djehiche.

Scientist
Henrik Hult.

Keywords
Multivariate time series, copulas, dependence concepts, elliptical distributions.

Project description
Investigation of dependence structures and dependence concepts for multivariate dynamic stochastic models including multivariate financial time series.

2.3. Rare events in stochastic processes and distributional approximations

Research leader
Torkel Erhardsson.

Keywords
Rare events, approximation, error bound, Stein's method, coupling.

Project description
We study random quantities related to rare events in stochastic processes (first occurrence times of rare events, the total number of rare events, etc.), and look for distributional approximations with explicit error bounds for such quantities. We also develop mathematical tools for constructing distributional approximations with error bounds, using techniques like Stein's method and couplings.

2.4. Risk theory and point processes

Research leader
Jan Grandell.

Keywords
Cox process, Lundberg inequality, martingale methods, ruin probability.

Project description
Generalization of the classical risk models to cases where the occurrence of the claims may be described by more general point processes than the Poisson process.

2.5. Random walks, Brownian motions, and extreme-values

Research leader
Lars Holst.

Scientist
Anna Carlsund.

Keywords
Random walk, Brownian motion, birth-and-death processes, extreme-values.

Project description
Calculations of probability distributions connected with simple random walks and birth-and-death processes and comparison with approximations based on diffusion processes related to Brownian motion. Investigation of extreme-value distributions for certain problems in combinatorial and geometric probability.

2.6. Percolation

Research leaders
Lars Holst, Olle Häggström (CTH).

Scientist
Per Hallberg.

Keywords
Ising (Pott's) model, particle systems, phase transition, percolation.

Project description
Investigation of phase transitions and percolation in the Ising (Pott's) model for infinite particle systems and their connection with existence and uniqueness of limiting probability measures for such systems.

3. Education

3.1. Undergraduate courses

The Department of Mathematics gives undergraduate courses in mathematical statistics at most programs of the Royal Institute of Technology (KTH); in all ten courses. The following courses have been given:

5B1501 Probability Theory and Statistics for the Program of Materials Technology, the Program of Electrical Engineering, the Program of Industrial Engineering and Management, the Program of Surveying, the Program of Mechanical Engineering, the Program of Media Technology, the Program of Vehicle Engineering, and the Program of Civil Engineering.

5B1504 Mathematical Statistics for the Program of Electrical Engineering.

5B1506 Mathematical Statistics for the Program of Computer Science and Technology, the Program of Engineering Physics, and the Program of Information and Communication Technology.

5B1538 Reliability Theory.

5B1540 Probability Theory.

5B1545 Time Series Analysis.

5B1550 Applied Mathematical Statistics.

5B1555 Computer Intensive Methods in Mathematical Statistics.

5B1570 Martingales and Stochastic Integrals.

5B1575 Financial Derivatives.

The first three courses are basic courses for the different programs of KTH. The last seven courses are upper level undergraduate courses. About 1300 students a year study courses in mathematical statistics; more than 2000 lessons are given each year.

The course 5B1550 was given in cooperation with the Institute of Actuarial Mathematics and Mathematical Statistics at Stockholm University.

The Department of Mathematics had also some responsibility for the examination in mathematical statistics at Mälardalen University.

3.2. Master theses (Examensarbeten)

Arnaud Leclerc: *Pricing Quanto Long-Term Warrants on Risky Bonds.* August 2001.

Johan Liljefors: *Static Hedging of Barrier Options under Dynamic Market Conditions.* September 2001.

Marcus Granstedt: *Kredit- och försäkringsderivat.* October 2001.

Michael Hemph: *Bond Trading Strategies Based on Term Structure Models.* October 2001.

Nikolas Santikos: *Pricing Spread options on Swaps.* October 2001.

Jonas Lundberg: *Option-Pricing with a "Smile" — Derivation of Probability Distribution via Relative Entropy Minimization.* November 2001.

Daniel Rutberg: *En studie av konjunkturberoende i svenska skadeförsäkringar.* November 2001.

Johan Sahlén: *Genetic Testing and Pricing of Insurance Contracts.* December 2001.

Johan Sandström: *Prissättning och hedging av temperaturberoende volymrisk på elmarknaden.* January 2002.

Fredrik Strandberg: *Tails and outliers in financial time series.* January 2002.

Mathias Barkhagen: *Value at Risk & Vega Risk — using the implied volatility surface to compute VaR for option positions.* January 2002.

Sead Omérov: *Comparison of methods for computing total variation distance bounds for compound Poisson approximations of word counts.* February 2002.

Mattias Bylund: *A Comparison of Margin Calculation Methods for Exchange Traded Contracts.* February 2002.

Henrik B. Kwarnmark: *A vector-autoregressive integrated market and macro factor default model.* February 2002.

Hanna von Euler: *Attempts to select customers from a database using Artificial Intelligence and Principal Component Analysis.* April 2002.

Marcin Ciolek: *Kreditrisk: Modellering av de nya kapitaltäckningsreglerna.* May 2002.

Marie-Claude Saisse: *Modelling the Time-Varying Risk Premium in a CAPM Framework.* June 2002.

Benoît Riquet: *Elliptical distributions in risk management.* June 2002.

Lars Karlsson: *GARCH-Modelling: Theoretical Survey, Model Implementation and Robustness Analysis.* June 2002.

4. Publications

4.1. Published papers

A. Berkaoui, B. Djehiche, Y. Ouknine: Sur les grandes déviations en théorie de filtrage non linéaire. *Studia Mathematica,* Vol. 148 (2001), pp. 5 – 21.

B. Djehiche, M. Eddahbi: Hedging options in market models modulated by fractional Brownian motion. *Stochastic Analysis and Applications,* Vol. 19 (2001), pp. 753 – 770.

A. Dermoune, B. Djehiche: Global solution of the pressure-less gas equations with viscosity. *Physica D,* Vol. 163 (2002), pp. 184 – 190.

B. Djehiche, M. Eddahbi, Y. Ouknine: A logarithmic Sobolev inequality for one-dimensional multivalued stochastic differential equations. To appear in *Probability and Mathematical Statistics,* Vol. 22 (2002).

P. Alaton, B. Djehiche, D. Stillberger: On Modelling and Pricing Weather Derivatives. *Applied Mathematical Finance,* Vol. 9 (2002), pp. 1 – 20.

Torkel Erhardsson: Refined distributional approximations for the uncovered set in the Johnson-Mehl model. *Stochastic Processes and their Applications,* Vol. 96 (2001), pp. 243 – 259.

Lars Holst: Extreme value distributions for random coupon collector and birthday problems. *Extremes.* Vol. 4 (2001), pp. 129 – 145.

Henrik Hult, Filip Lindskog: Multivariate Extremes, Aggregations and Dependence in Elliptical Distributions. To appear in *Advances in Applied Probability.*

Johan Irbäck: Asymptotic theory for a risk process with a high dividend barrier. To appear in *Scandinavian Actuarial Journal.*

Harald Lang, James W. Albrecht, Susan Wroman: The Effect of Information on the Well-Being of the Uninformed. *International Journal of Industrial Organization,* Vol. 20 (2002), pp. 139 – 162.

4.2. Technical reports and preprints

A. Dermoune, B. Djehiche: *A probabilistic family of solutions of the pressure-less gas equations.* Submitted for publication.

Lars Holst: *The Poisson-Dirichlet distribution and its relatives revisited.* Submitted for publication.

Henrik Hult: *Weak convergence to fractional Brownian motion in Besov spaces.* 2001.

5. Seminars

2001

Sept. 10.   **Lars Holst:** *Om Poisson-Dirichlet-fördelningen.*

Sept. 21.   **Johan Liljefors:** Presentation of Master thesis: *Static Hedging of Barrier Options under Dynamic Market Conditions.*

Sept. 24.   **Bronius Grigelionis,** Vilnius: *On the extreme value theory for H-diffusions.*

Oct. 1.   **Fredrik Armerin:** *Stochastic volatility — The Fouque-Papanicolaou-Sircar approach.*

Oct. 8.   **Marcus Granstedt:** Presentation of Master thesis: *Kredit- och försäkringsderivat.*

Oct. 15.   **Michael Hemph:** Presentation of Master thesis: *Bond Trading Strategies Based on Term Structure Models.*

Oct. 15.   **Nikolas Santikos:** Presentation of Master thesis: *Pricing Spread options on Swaps.*

Oct. 22.   **Torkel Erhardsson:** *Strong memoryless times and rare events in stationary Markov renewal processes.*

Oct. 29.   **Henrik Hult:** *Multivariate extremes and dependence in elliptical distributions.*

Nov. 5.   **John Wierman,** Johns Hopkins University, Baltimore, USA: *Critical probabilities in percolation theory: Bounds, conjectures, and counter-examples.*

Nov. 12.   **Jonas Lundberg:** Presentation of Master thesis: *Option-Pricing with a "Smile" — Derivation of Probability Distribution via Relative Entropy Minimization.*

Nov. 19.   **Lars Holst:** *Om Poisson-Dirichlet-fördelningen, spec. Dickmans funktion.*

Nov. 20.   **Daniel Rutberg:** Presentation of Master thesis: *En studie av konjunkturberoende i svenska skadeförsäkringar.*

Dec. 3.   **Lars Holst:** *Om Poisson-Dirichlet- och GEM-fördelningen, och Ewens stickprovsformel.*

Dec. 10.   **Johan Sahlén:** Presentation of Master thesis: *Genetic Testing and Pricing of Insurance Contracts.*

2002

Jan. 14.   **Johan Sandström:** Presentation of Master thesis: *Prissättning och hedging av temperaturberoende volymrisk på elmarknaden.*

Jan. 14.   **Fredrik Strandberg:** Presentation of Master thesis: *Tails and outliers in financial time series.*

Jan. 21.   **Lars Holst:** *Om Poisson-Dirichlet-fördelningen, spec. residual-allokeringsmodeller, och Ewens stickprovsformel.*

Jan. 28.   **Mathias Barkhagen:** Presentation of Master thesis: *Value at Risk & Vega Risk — using the implied volatility surface to compute VaR for option positions.*

Febr. 4.   **Lars Holst:** *Om cykler i slumppermutationer.*

Febr. 18. **Sead Omérov:** Presentation of Master thesis: *Comparison of methods for computing total variation distance bounds for compound Poisson approximations of word counts.*

Febr. 18. **Henrik Hult:** *Excursions in the Brownian motion and the Brownian bridge and relations to the two-parameter Poisson-Dirichlet distribution.*

Febr. 21. **Mattias Bylund:** Presentation of Master thesis: *A Comparison of Margin Calculation Methods for Exchange Traded Contracts.*

Febr. 21. **Henrik B. Kwarnmark:** Presentation of Master thesis: *A vector-autoregressive integrated market and macro factor default model.*

Febr. 25. **Sven Erick Alm,** Uppsala University: *Om avvikelsen mellan väntevärde och median för Gammafördelningar och ett av Ramanujans problem.*

March 4.   **Göran Einarsson,** Department of Signals, Sensors and Systems, KTH: *Kvantinformationsteori.*

March 11. **Göran Einarsson,** Department of Signals, Sensors and Systems, KTH: *Kvantdatorer.*

April 10. **Hanna von Euler:** Presentation of Master thesis: *Attempts to select customers from a database using Artificial Intelligence and Principal Component Analysis.*

April 22. **Olle Häggström,** Chalmers University of Technology and Göteborg University: *Couplings: Old and new ideas: Coupling of Markov chains.*

April 24. **Olle Häggström,** Chalmers University of Technology and Göteborg University: *Couplings: Old and new ideas: Coupling of random walks.*

April 29. **Olle Häggström,** Chalmers University of Technology and Göteborg University: *Couplings: Old and new ideas: Coupling of renewal processes.*

May 2.   **Olle Häggström,** Chalmers University of Technology and Göteborg University: *Couplings: Old and new ideas: Some important inequalities: Holley, Harris and FKG.*

May 6. **Olle Häggström,** Chalmers University of Technology and Göteborg University: *Couplings: Old and new ideas: Max-flow min-cut and Strassen's theorem.*

May 8. **Olle Häggström,** Chalmers University of Technology and Göteborg University: *Couplings: Old and new ideas: The Propp-Wilson algorithm and stochastic monotonicity.*

May 13. **Bengt Rosén,** Uppsala University: *Om statistikproduktion i u-land, särskilt s.k. Master Samples.*

May 14. **Marcin Ciolek:** Presentation of Master thesis: *Kreditrisk: Modellering av de nya kapitaltäckningsreglerna.*

May 27. **Brahim Mezerdi,** Biskra University, Algeria: *A maximum principle in relaxed stochastic control problems.*

June 14. **Marie-Claude Saisse:** Presentation of Master thesis: *Modelling the Time-Varying Risk Premium in a CAPM Framework.*

June 14. **Benoît Riquet:** Presentation of Master thesis: *Elliptical distributions in risk management.*

June 14. **Lars Karlsson:** Presentation of Master thesis: *GARCH-Modelling: Theoretical Survey, Model Implementation and Robustness Analysis.*

6. Presentations by staff

Fredrik Armerin: *Cash flow valuation in discrete time.* Seminar at Humboldt Universität, Berlin, June 6, 2002.

Boualem Djehiche: *Att mäta risker på de finansiella marknaderna.* Sveriges finansanalytikers förening, November 13, 2001.

Boualem Djehiche: *Aspects of risk analysis in insurance and finance, or what do practitioners in insurance and finance at the end of the day?* Seminar at the Department of Mathematics, Lille University, March 27, 2002.

Boualem Djehiche: *Fair valuation of insurance contracts.* Conference on Global Investment Strategies, Barcelona, May 23, 2002.

Boualem Djehiche: *An overview on pricing insurance contracts.* Seminar at Campus Norrköping, Linköping University, June 5, 2002.

Torkel Erhardsson: *Compound Poisson approximations for visits to rare sets by stationary Markov chains and regenerative processes.* Seminar at Mälardalen University, Västerås, April 10, 2002.

Jan Grandell: *Risk theory.* Seminar at University of Linköping, April 17, 2002.

Jan Grandell: *Risk theory and geometric sums.* Seminar at University of Copenhagen, May 28, 2002.

Lars Holst: *Longest excursion in a Brownian bridge.* 27th Conference on Stochastic Processes and their Applications, Cambridge, England, July 10, 2001.

Lars Holst: *On the longest cycle and record in a random permutation.* Symposium on Probability and Algorithms, KTH, August 22, 2001.

Lars Holst: *On cycles in random permutations.* Seminar at Chalmers University of Technology, May 23, 2002.

Henrik Hult: *Multivariate extremes for stochastic processes.* Seminar in Financial and Insurance Mathematics at ETH, Zürich, April 17, 2002.

Henrik Hult: *Extremal dependence in finance.* NORDSTAT, 19th Nordic Conference in Mathematical Statistics, Stockholm University, June 12, 2002.

7. Conferences, guest researchers, etc.

Most of the staff participated in NORDSTAT, the 19th Nordic Conference in Mathematical Statistics, Stockholm University, June 9 – 13, 2002.

Fredrik Armerin and **Henrik Hult** participated in a minicourse at Helsinki University on "Optimal Stopping and Parameter Estimation in Diffusion Processes", August 27 – 30, 2001.

Fredrik Armerin and **Torkel Erhardsson** participated in Summer School on Stochastics and Finance, University of Barcelona, September 3 – 7, 2001.

Boualem Djehiche participated in the International AFIR Conference, Toronto, September 1 – 6, 2001.

Boualem Djehiche was Guest Professor at the Department of Mathematics, Lille University, March 2002.

Boualem Djehiche participated in Conference on Global Investment Strategies, Barcelona, May 22 – 24, 2002.

Boualem Djehiche participated in Workshop on Insurance and Genetics, Heriot-Watt University, Edinburgh, May 29, 2002.

Jan Grandell and **Lars Holst** participated in the Lunteren Meeting, Holland, November 12 – 14, 2001.

Per Hallberg and **Lars Holst** participated in Symposium on Probability and Algorithms, KTH, August 22 – 23, 2001.

Per Hallberg participated in Workshop on Discrete Probability at EURANDOM, Eindhoven, June 17 – 20, 2002.

Lars Holst participated in the 27th Conference on Stochastic Processes and their Applications, Cambridge, England, July 9 – 13, 2001.

Henrik Hult participated in a MAPHYSTO course at University of Copenhagen, "Advanced Concentrated Course on Long Range Dependence, Heavy Tails and Rare Events — Applications to Finance and Telecommunications", May 6 – 10, 2002.

8. Other activities

Boualem Djehiche is a regular reviewer for Mathematical Reviews.

Boualem Djehiche is Swedish editor of Scandinavian Actuarial Journal.

Boualem Djehiche is a referee for Advances in Applied Probability, Probability Theory and Related Fields, and Scandinavian Actuarial Journal.

Boualem Djehiche has a part-time position as Head of Risk Management at Skandia Liv Asset Management.

Boualem Djehiche is a member of a committee suggested by the Swedish Insurance Federation to work out premium calculation rules for life insurance policies for people susceptible to hereditary diseases.

Boualem Djehiche is a member of a committee suggested by the Swedish Actuarial Society to work out a master program in Actuarial Mathematics.

Boualem Djehiche organized a forum called "Finanskontakt", bringing together undergraduate students and representatives of major banks and financial institutions in Sweden. This took place on October 17, 2001.

Jan Enger is coordinator of the Swedish work in the international standardization committees ISO/TC69 Applications of Statistical Methods and ISO/TC 176 Quality Management and Quality Assurance. He is a member of the working groups on Statistical Sampling Plans belonging to ISO/TC69. He was one of the Swedish delegates at the meetings of the above-mentioned committees.

Jan Enger is a member of the Committee on Quality of Jernkontoret.

Jan Enger is a member of the Six Sigma Steering Group at Ericsson.

Gunnar Englund is senior biostatistician at AstraZeneca.

Torkel Erhardsson is a referee for Probability Theory and Related Fields, Scandinavian Journal of Statistics, and Stochastic Processes and their Applications.

Jan Grandell is a referee for Applied Probability.

Jan Grandell is censor at the Faculty of Natural Sciences at the University of Copenhagen, Denmark.

Jan Grandell is a regular reviewer for Mathematical Reviews.

Per Hallberg was a member in the organization committee of NORDSTAT, 19th Nordic Conference in Mathematical Statistics, Stockholm University, June 9 – 13, 2002.

Lars Holst is a regular reviewer for Mathematical Reviews and Zentralblatt für Mathematik. He is a referee for Annals of Probability, Annals of Applied Probability, Advances of Applied Probability, American Mathematical Monthly, Random Structures and Algorithms, and Statistics and Probability Letters.

Lars Holst was a member of the examination committees at the Ph.D.-dissertations of Anders Ledberg, Karolinska Institutet, September 21, 2001, and Dan Mattsson, Chalmers University of Technology, May 28, 2002.